FEB 3 1911

SCIENTIFIC AMERICAN SUPPLEMENT, No. 1831

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Copyright, 1910, by Munn & Co., Inc.

Published weekly by Munn & Co., Inc., at 361 Broadway, New York.

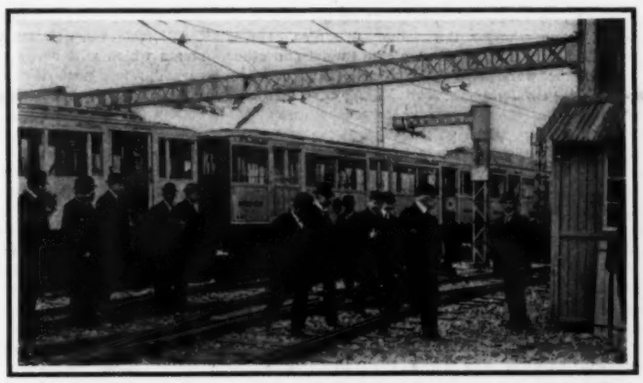
Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXXI., No. 1831.

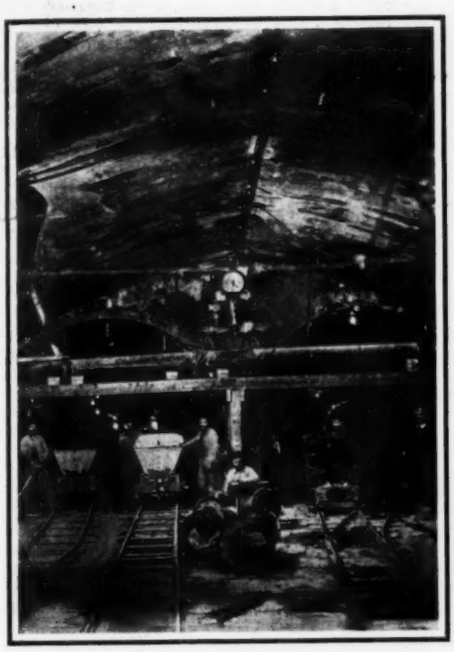
NEW YORK, FEBRUARY 4, 1911.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

VIEW IN ROTUNDA HALL AT ST. LAZARE DEPOT OF NEW PARIS SUBWAY

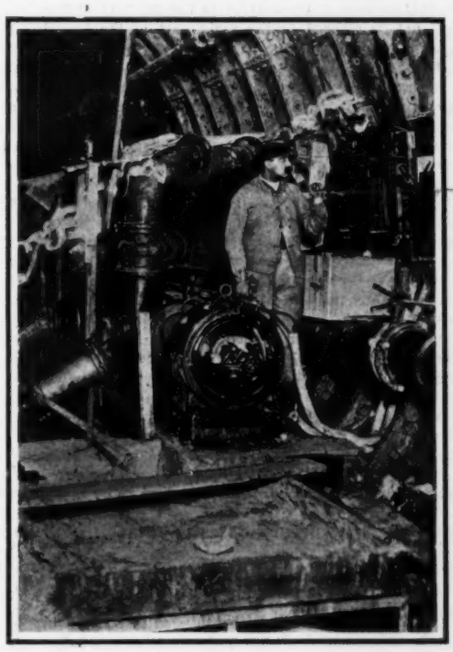


PARIS COMMISSION OF CONTROL VISITING NEW NORTH-SOUTH SUBWAY. VIEW OF YARDS, SHOWING TRAIN

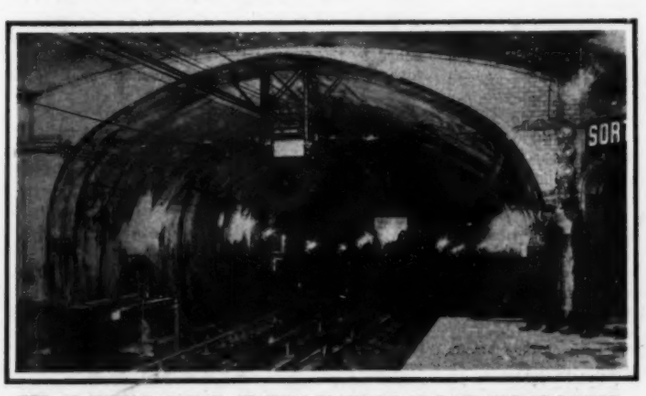


TUNNEL UNDER THE SEINE. STARTING POINT OF THE TWO TUBES, SHOWING UNDERGROUND STATION

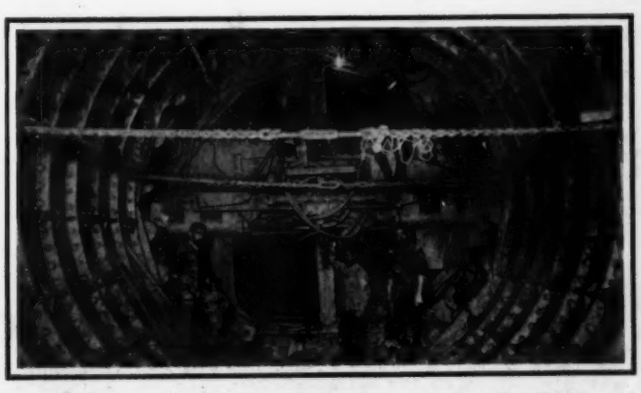
BERLIER TUBE OF PARIS SUBWAY UNDER THE SEINE



CONSTRUCTION WORK, BERLIER TUBE. THE WATER-DRIVEN PUMPS



END OF SUBWAY STATION, SHOWING PLATFORM ON EACH SIDE OF DOUBLE TRACK; STANDARD TUNNEL TROLLEY WIRES, THIRD RAIL; EXIT AT RIGHT, ETC.



SHIELD OF BERLIER TUBE CONSTRUCTION OF NEW PARIS SUBWAY

THE NEW PARIS ELECTRIC SUBWAY

A New Electric Subway in Paris

The North-South Line

By the Paris Correspondent of the Scientific American

PARIS now has a new line of electric subway in operation, and it is likely to prove a favorite with the public. While it is laid out on about the same general plan as the Metropolitan subway whose different sections run through the city, it was constructed and operated by an entirely different company. As regards the tunnel work of the line, which is known as the North-South subway, we would refer to an account which we previously published at the earlier stages of this construction, illustrating the steel tube tunnel running under the Seine. We also present some views which were taken of the tunnel and other parts of the work at a later period than those accompanying our former article. The remainder of the views showing the subway, in its finished state, the trains, etc., were taken at the time of the official inauguration of the line early in November. On this occasion the Prefect of the Seine and delegates representing the ministerial department of public works, the Municipal Council and other official bodies, made a visit to the line, and on the following day it was opened to the public.

For most of the way there is used a double track tunnel, the tracks being standard gage and employing the third rail system for taking the current. Each track, however, runs in a separate tube when passing under the Seine. In addition to the third rail, an overhead wire is run along the tunnel, and the motor cars are run by trolley as well as on the third rail system. Short side tracks are placed at intervals in the tunnel, which is here enlarged to receive them, so that in case of obstruction to the track the trains will not be stopped in the main part of the tunnel, but can be sidetracked.

It will be remembered that the North-South line was organized on an entirely different financial and operating basis from the regular Metropolitan subway. Some years ago the plans for the Metropolitan were drawn up so that when finished it would cover the whole town by its different sections, as nearly as this could be realized. When entirely completed, which will take several years to come, there will be no less than 70 miles of subway in operation. However, it was noticed that a gap had been left in certain quarters of the town, and it would be desirable to cover this, so as to connect the southern quarters of Vaugirard and Montparnasse with the northern quarter of Montmartre. For this reason the North-South company was formed quite outside the Metropolitan system, in order to have the new subway constructed more rapidly than would otherwise have been the case.

The total length of the line when finished will be about 9 miles. At present it ends shortly after the St. Lazare railroad depot, and the remainder is at present in construction. There are now finished 18 stations, starting from the Versailles Gate and running by the Montparnasse Depot, crossing the Seine at the Place de la Concorde and reaching the St. Lazare Depot. When completed, there will be 30 stations in all. It was specially desired to connect the two railroad stations, so as to give a more direct transit between these two points.

Profiting by the experience already obtained in running the older subway during the last few years, the North-South line has a number of minor improvements which will be appreciated by the public. The cars did not need to be changed over from single truck to double bogie, as was the case for the Metropolitan line and involving considerable expense, as did also the adoption of fire-proof motors after the very disastrous fire at the Couronnes station, where so many passengers lost their lives by being smothered by the smoke from the burning train. In the present case the cars are run from the start upon double bogie, and all the most recent improvements have been made in the motors and controling apparatus. The motor cars are built on the plan which follows the most approved practice, that is, the cabin is located at the car end and is quite partitioned off from the rest of the car, with a small access door. The remainder of the car is devoted to seating and standing places, on the central passage system, following about the same plan as for the other subway. Motor cars and trailers go to form the train, the trailers differing only in the absence of the cabin. Good lighting and ventilation add to the attractiveness of the cars. The first and second-class cars have scarcely any difference, except that they are painted outside in buff and blue color respectively.

A general elliptical section is given to the stations, and they are reached by staircases which descend from openings in the pavement. These openings cannot be housed over as a general rule, owing to the obstruction which they would give to the view. Some difficulty was found in the old line in obtaining a suitable non-slipping material for the steps when they were made wet by rain. For the new line pressed carborundum has been used for this purpose. It is very durable and at the same time excellent in preventing slipping. As the line crosses the different sections of the other subway at four different points, it was required to make the transfer in the proper manner so that passengers can go from one line to the other.

Each subway has a separate station, and these are connected by underground passages. No extra charge is made in any case for the transfer, the price of tickets being 3 cents for second class and 5 cents for first class on both lines. Before 9 o'clock there are delivered to employees return tickets for 4 cents, which allows of a return at any time of day.

At the St. Lazare railroad depot there has been constructed an underground rotunda hall which is used as a centering point for the numerous passageways. These are needed for the two subway stations, the passage leading to the railroad station, and the street entries and exits. One part of the rotunda is here represented. It is surrounded with recess windows which are to contain displays of different kinds. In the center are the ticket offices and newstands. The hall has a vaulted ceiling upheld upon columns, and its design is tastefully carried out. Another station at the Rue Falguière is worthy of remark from the fact that it is built of reinforced concrete. We have already illustrated this work, and it will be remembered that the present material was adopted on account of the narrowness of the street between the house foundations. The side walls of the elliptical station had to be very thin in order to keep the same standard inside space. The problem was very well solved by the use of reinforced concrete, so that a side wall of but 0.61 meter (2 feet) could be employed.

The stations are lined with white enameled brick, and the name of the station is shown in large letters of colored brickwork. Owing to the difference in the colored brick trimming of the station, green or brown, passengers can see at a glance which are the stations for making transfers. The present tunnel does not run in a loop at the terminals, as before, but the trains are simply reversed, these being adapted for running either way. One of our views shows the train at the station yards, which lie outside the tunnel near the Versailles gate. A somewhat novel feature is the use of a combined third rail and overhead trolley system for operating. Here the third rail is insulated and carries one side of the current, while the other pole of the current is connected to the overhead wire, using the ground (or track rails) as the common return.

This gives a three-wire system, and 1,200 volts are used in all in order to operate the two 600-volt motors of a car, in the same way as two 110-volt lamps are coupled upon the 220-volt three-wire system. In the case of the two motors, one side of motor No. 1 is thus connected to ground or the track rail, and the other side to the third rail. Motor No. 2 is connected on one side to ground and on the other to the trolley wire. The load is about even on each motor, owing to the controller combinations. By this method 1,200 volts are used on the current mains and consequently on half the current for the same power as if 600 volts were used, and this reduces the size of the wiring.

RULES GOVERNING THE COMPETITION FOR THE $15,000 FLYING MACHINE PRIZE OFFERED BY MR. EDWIN GOULD.

1. A prize of $15,000 has been offered by Mr. Edwin Gould for the most perfect and practicable heavier-than-air flying machine, designed and demonstrated in this country, and equipped with two or more complete power plants (separate motors and propellers), so connected that any power plant may be operated independently, or that they may be used together.

CONDITIONS OF ENTRY.

2. Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown, with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the GOULD-SCIENTIFIC AMERICAN Prize, 361 Broadway, New York city. Each contestant, in formally entering his machine, must specify its type (monoplane, biplane, helicopter, etc.), give its principal dimensions, the number and sizes of its motors and propellers, its horsepower, fuel-carrying capacity, and the nature of its steering and controlling devices.

3. Entries must be received at the office of the SCIENTIFIC AMERICAN on or before June 1st, 1911. Contests will take place July 4th, 1911, and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE.

4. The committee will consist of a representative of the SCIENTIFIC AMERICAN, a representative of the Aero Club of America, and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST.

5. Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison. No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight, over a designated course; and for a period of at least one hour he must run with one of his power plants disconnected; also he must drive his engines during said flight alternately and together. Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines, the questions of stability, ease of control, and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6. All heavier-than-air machines of any type whatever—aeroplanes, helicopters, ornithopters, etc.—shall be entitled to compete for the prize, but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7. The flights will be made under reasonable conditions of weather. The judges will, at their discretion, order the flights to begin at any time they may see fit, provided they consider the weather conditions sufficiently favorable.

8. No entry fee will be charged, but the contestant must pay for the transportation of his machine to and from the field of trial.

9. The place of holding the trial shall be determined by the Contest Committee, and the location of such place of trial shall be announced on or about June 1st, 1911.

Lieut. Bouvet has been making excavations at the Roman *castellum* of Ras-el-Ain Tlalet in the North African region, owing to a subsidy received from the Tunis archæological department. It is a fortified place of square shape, of about 300 feet on a side. The walls are 5 feet thick and are rounded at the four corners like the fort of El Hagueuf. Doors are observed on the north and south sides, but not in the center. The construction resembles that of the ancient camps of the Roman legion. Cavities below the ground level are found, which appear to be Christian tombs. One of these, 7 feet deep, contained a square pitcher and a Christian lamp. Probably the tombs were violated in ancient times. A chamber resembling a cellar was also found, and it contained the débris of about thirty amphoræ with numbers printed on them. Lamps, coins, and vases were found in this place.

The Armament of Battleships

Sir William White's Views

THE general principles of warship designs belong to no one nation. It needs, however, the practical as well as the theoretical experience of past years, gained both at sea and in office, of experimental work afloat and ashore, and of design work tempered by the judgment of its unbiased users, to produce a ship, especially one for purposes of war, in which everything is not only placed to the best advantage, but which shall simultaneously possess the important quality of fighting power associated with peace time convenience and habitability. Just at the present moment, when the competition in naval armaments has pressed to the very utmost the output resources of the great armament firms in England, Germany, and the United States, the views of Sir William White, as they appear in an interesting paper on the subject of battleship armaments to the Society of Naval Architects and Marine Engineers in New York, are of more than usual interest. Sir William has probably designed more warships than any other naval architect, and his views have invariably been expressed with a temperate logic that goes far to carry conviction in the face of marked and able differences of view, enunciated more emphatically, but almost inevitably based on shorter experience of the subject under discussion. Sir William's views in his latest paper indicate very clearly that his reputation for clarity of exposition has lost none of its force since he resigned the position of Chief Constructor to the Royal Navy.

The arguments in the paper under discussion reflect very fairly the views of the two camps into which gunnery schools may be said to be divided. One is the all-big-gun one-caliber school, while the other advocates a secondary armament for battle purposes. As Sir William points out at the beginning of his paper, the fundamental idea which has governed the armaments of warships in all ages is the desire to provide means of offence which will enable a ship to destroy her adversary in the shortest possible time with the minimum damage to herself, and active offence still constitutes the best, though not the only means of doing so. The best arrangement of armament for this purpose is discussed largely on the lines of Sir William's criticism of Admiral Bacon's paper on the "Battleship of the Future," read before the Institution of Naval Architects in London early in 1910, and more space being at his disposal on this occasion, the pros and cons of the "Dreadnought" type are comprehensively analyzed, and deliberate opinions expressed as a result. Let it be said at once that Sir William advocates the re-adoption of the 6-inch gun as a fighting weapon in association with not more than four twin center line turrets arranged as in the "South Carolina," an arrangement which it is said is to be adopted in the new Japanese battleship now being built at Barrow. Whether the big-gun advocates will believe that in the latter case the secondary armament is for fighting or for anti-torpedo-boat purposes, is another matter. Their view was given in these columns some few weeks ago in a leading article on the resuscitation of the medium caliber weapons.

It is generally agreed that battle ranges have inevitably increased of late years, owing to the development of the locomotive torpedo, and to systems of fire control associated with improved gunnery. Conflicting views are held as to what the range will be. Climatic conditions, and a serious intention of attaining a decisive issue, may tend to reduce the range that would be chosen by the faster all-big-gun ships. Herein lies the crux of the situation. When the earlier Dreadnoughts were built, their speed gave them the advantage of choosing the range. Now that there are numerous ships of this type, as well as much faster torpedo craft afloat, there is, as we pointed out in the article referred to, a strong tendency to develop the smaller weapons. But for what purpose? Not for battleship attack directly. For indirect attack, for keeping up a "blanketing" fire with the object of making it difficult for the enemy to see the attacking ship and on the off chance of their effecting damage to unarmored structures and communications which influence fighting efficiency they may be useful, but it becomes a question, as Admiral Bacon said, as to whether adequate value for tonnage involved is obtained by their adoption. Obviously, if they are installed at all they can be used for any or all purposes as long as they remain in action. The "volume of fire" obtainable from such quick firing would, some say, inflict considerable damage, and the experience of the Russians at Tshushima is generally dragged in to prove it. It is in this case. Well, in Capt. Semenoff's book, quoted in the paper under review, we find on page 124 the remark: "That's only a 6-inch; no more 'portmanteaux' now!"—the word referring to the Japanese 12-inch shell. Again, on page 135: "There was a loud crash . . . this was not a 6-inch shell, but the 'portmanteaux' again. The men became seized with panic. . . ." Semenoff tells ably of the utter destruction due to shell fire, but his words are apt to be misread; the heavy shell was what they feared, and a similar well-directed fire from the Russian ships—secondary or primary, or big torpedo—would have kept the Japanese much farther away, obviously leaving the action even more to a question of "portmanteaux." With this practical experience in view, it is impossible to reconcile Sir William's reason for believing that actual trials do not confirm the objection to mixed armaments on the ground that the simultaneous discharge of guns of different calibers must be accompanied by diminished efficiency in the control of fire and in the proportion of hits to rounds made by guns of different calibers. As we stated some time ago, when gun fire is handled so as to obtain hits, not merely volume of fire, the rapidity of discharge is much below the possible rapidity of fire of the gun. Admiral Bacon suggests that it is merely a quarter of the potential rapidity, and aptly remarks that rapidity of fire, unaccompanied by rapidity of hitting, is a futile waste of ammunition. We hold most strongly that in the King Edward class, for instance, the accuracy of 6-inch fire is materially affected by the simultaneous discharge of the 9.2-inch and 12-inch guns. It suffers also in rapidity from the smoke nuisance.

In referring to the number of heavy guns to be mounted, Sir William advocates pairs, and goes on to note the extraordinary Italian practice of mounting three triple and two twin turrets in the "Dante Alighieri" class. Triple turrets involve insuperable objections to practical gunners of the "hit-the-target" order; besides being too many eggs in one basket, they suffer from smoke interference and "throw-off" to an excessive extent. The relationship of protective material and the adequate support of the same also receives attention. In many foreign vessels we find turret roller paths fixed directly to or supported on the vertical barbette armor—a most dangerous practice, as in action the combined efficiency of the heavy gun armament, in spite of heavy blows on the protective armor, is a primary consideration. Adequate clearance between fixed and moving portions of a turret should always be allowed in spite of the increased overall dimensions and weight necessary. Reference is made to the maximum number of heavy guns that should be carried by a warship. Here the author is on much safer ground. In tonnage value for effect obtainable, it is hard to believe that it is possible to improve on the arrangement, first adopted in the United States battleship "Michigan," of four twin turrets on the center line the two inner turrets firing over the two end turrets. Such an arrangement possesses the great advantage of minimum interference between turrets due to "blast. The system adopted in the "Inflexible" class, in the "Von der Tann," or the Spanish battleships, of having two center line and two echelon turrets, really reduces these vessels in practice to the status—considering broadside work only—of six-gun ships. On paper, the echelon arrangement allows three pairs of turrets to five ahead and astern on the keel line. On board, such a discharge causes unpleasant consequences, and the limits of safe training in practice are considerably less than the extremes shown on the drawings. Of course, automatic danger signals —generally shrill buzzers by the side of the turret-training levers—are supposed to warn the gun-layer when he risks his own or his neighbor's comfort from blast, but these are extremely apt to be unreliable in action, and the system of mounting guns to avoid this, even if the number of heavy guns be reduced, will probably be found best in service. The advantage conferred by confining the primary armament to the ends of a ship, as far as magazine accommodation is concerned, is very considerable. Side turrets, as in the "Dreadnought" or "Minas Giraes," are inconvenient—the "Nassau" is very bad with four large turrets crowded together—owing to the difficulty experienced of making a good boiler and engine-room arrangement. Sir William does not touch on the point beyond referring to the objection to mixing stokeholds and magazines, but it entails probably an additional row of boilers to make up for the staggered units cut out by an echelon arrangement, or an increased length over the machinery space to allow for a transverse magazine. This involves a corresponding addition to the length, weight, and cost of the heavy belt armor. In view of this and the question of interference, his deliberately expressed convictions that in no case is it desirable to mount more than eight heavy guns in a single ship, and that these are best arranged in four positions, as in the "Michigan" class, will meet with less criticism than his third view that they should be supplemented by a powerful and well-protected secondary armament.

A large number of naval officers want a protected 6-inch battery reintroduced, in spite of their expressed conviction that its fire may be discounted at ordinary battle ranges when accompanied by a 12-inch gun fire. Here is where Sir William takes an opposite view. A secondary battery mounted as in the "Michigan" on the upper deck is, in our opinion, vastly better than the corresponding main deck battery of the "Delaware." With, however, the smoke nuisance from the heavy guns, the continual anticipation of blast effect from overhead and the lower rate of fire inevitable from these causes, as well as from the desire for accuracy, it is hard to agree with him. The naval desire for the reintroduction of the 6-inch gun arises from a belief that it is a better anti-torpedo gun than the 4-inch. Opinions on this point also differ widely. If the increased caliber of heavy guns tends to put up battle ranges, then it probably is; but, as we stated in the article we referred to, the 4-inch should also be retained, in our opinion, for mounting in the superstructure.

At the conclusion of his paper Sir William turns to the important point of future gun caliber, and draws a trenchant parallel between present practice and that of twenty years ago. All the arguments that held good for the increase from 12-inch to 13.5-inch hold good for an early advance to 15-inch or 16-inch. Such a gun is being made, we believe, at the present time. No argument is raised against such a caliber, except that of larger or more costly ships. This has never been heeded. Warships of all kinds are generally smaller than merchant vessels, and for many years the largest have never exceeded about 60 per cent of the greatest mercantile displacement. There are at present at least four ships being built with over 60,000 tons full load displacement, and an increase in warship size is inevitable in the early future. So it is with speed. The "Von der Tann" and "Lion" will set examples of a far-reaching kind. Nothing is said of the tactical influence of speed or armament in the paper under review, but it is obviously considerable. Meanwhile, in spite of Sir William's generous treatment of the subject, we feel assured that the big-gun school, adhering to the results of their practical experience, will remain unconvinced that for fighting purposes anything less than the biggest convenient gun is worth having.—*The Engineer.*

MR. H. E. WIMPERIS, M.A., Assoc. M. Inst. C. E., before the British Association for the Advancement of Science, described the form of accelerometer recently invented by him. The instrument consists of a brass box about 4 inches across containing a copper disk mounted on a vertical pivot and "damped" in its motions by a permanent magnet. The c.g. of the disk is purposely removed from the axis so that when the box moves forward, one side of the disk tends to lag behind, thus partially winding up a coiled spring and actuating a pointer which moves over a scale. To render the reading unaffected by any accelerations at right angles to the direction of motion, a second parallel axis is fitted, which is geared to the first one, and has attached to it masses having the same mass moment as the disk itself. Couples about these two axes add up in the direction of motion, but neutralize one another in any direction at right angles. The accelerometer therefore reads in one of the three directions of space only, and is not affected by even violent movements in the other two directions. With this instrument the author has measured the road resistance of various classes of road, and has obtained figures varying from 50 pounds to 210 pounds per ton. On main line railways the resistance is usually from 12 pounds to 30 pounds per ton, depending on the speed. Measurements have also been made of the resistance to motion when a motor-car is coasting. In this way the horse-power and the engine friction can be measured, and a figure for the mechanical efficiency be obtained.

The conclusions reached may be summed up as follows: By the use of the accelerometer road resistances can be read off at sight; the air resistance of the various shapes of car body can be determined; the brake horse-power and indicated horse-power of the engine can be obtained for various speeds; and that it is possible to trace step by step the losses of power in transmission to the road wheels.

Some Notes on Telephony*

Facts and Principles Underlying Modern Practice

By H. Harrison, '07

I.

In writing this article it is my object to bring together concisely such fundamental and general information pertaining to telephony which is not readily available to the technical man not directly engaged in this phase of engineering activity.

Of the many telephone systems in operation, no one can be said to typify universal practice. Each has some peculiarity which renders it especially adaptable for some particular situation not possessed by the other. Fundamentally, however, all of the systems are alike; it is only in the devices employed to get successful results that practice varies so widely. With this in view, the text, circuits, and sketches will aim to emphasize general principles only.

II.

Any variation of resistance in a circuit will pro-

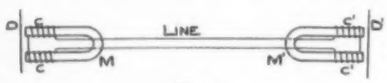


Fig. 1

duce a variation of current; upon this principle depends the successful electrical transmission of speech. The *variation of current* is the essential point. Fig. 1 illustrates this. *M* and *M'* are both permanent magnets. The coils *cc* and *c'c'* are wound around the ends of these magnets and are connected in series with the line. *D* and *D'* are soft iron diaphrams. Normally the magnetic flux produced by *M* and passing through the coils *cc*, remains unchanged. Any change in this magnetic flux will induce an electromotive force in *cc* and this in turn will produce a current in any circuit with which *cc* may be connected. Voice waves upon striking *D* will cause it to move to and fro, thus varying the distribution of the magnetic flux set up by *M* and producing currents in *cc*. These currents will vary (1) in strength according to the intensity of the motion of *D*, and (2) in direction according as *D* in moving toward or away from *M*. Such a *variation of current* in *cc* will cause the magnet *M'* to be correspondingly strengthened and weakened, thus exerting a varying pull on *D'* and reproducing the original voice waves faithfully.

In the scheme outlined above, the talking currents are produced by virtue of the transmitter acting as a generator or dynamo, the power for driving the dynamo being derived from the particles of air engaged in constituting the sound waves. The currents so produced must of necessity be very weak, and therefore only effective for comparatively short lines. To overcome this defect a transmitter has been devised which depends for its action on causing variation in the strength of a current generated by an outside source. The variation of current is obtained by making use of the principle that, if the pressure between two conducting bodies forming part of an electric circuit be varied, the resistance of the path between them will also be varied. Fig. 2 illustrates this.

The current from the battery passes through the

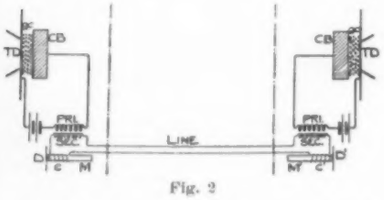


Fig. 2

primary of an induction coil and through a mass of granular carbon *gc*, which lies loosely between a carbon block *CB* and the diaphragm *TD*. Any sound waves striking *TD* will produce a slight to and fro motion of the diaphragm which will cause the resistance of *gc* to vary. This variation of resistance will cause corresponding changes of current in the primary circuit, thus inducing currents in the secondary which pass over the line and affect *M* and *M'* (both acting as receivers) as has been explained under Fig. 1.

It might be well, at this point, to call attention to the fact that the varying current in the primary of the induction coil is undulating in character and always in the same direction. The secondary current is, however, alternating in character, its direction depending on whether the primary current is increasing or diminishing in strength. Then again, by virtue of the large size of wire and the small number of turns in the primary winding of the induction coil, and the comparatively small size of wire and the large number of turns in the secondary winding, a comparatively high voltage is available with which to send the talking currents over long lines of high resistance.

Fig. 2 embodies all the elements essential for the effective transmission of articulate speech. There is lacking, however, a signaling system so that an individual at one instrument can call the attention of an individual at another instrument in the same system when communication is desired. For such a purpose, the magneto hand generator, in circuit with a polarized bell, is very largely used, and affords a most reliable signaling apparatus. Fig. 3 illustrates this.

The magneto hand generator is an alternating current machine, depending for its action on the principle governing the action of all dynamo-electric machines, i. e., that if the number of lines of magnetic force passing through a closed coil be varied, currents of electricity will be generated in this coil, the direction of these currents depending upon the direction of the lines of force and on whether their number is decreasing or increasing.

The armature *A* is wound with a large number of turns, thus permitting *the* variation in the number and direction of the lines of magnetic force that pass through it in its various positions, as the crank *C* (Fig. 4) is turned. The lines of force are produced by the permanent magnet *NS*. (Fig. 3.)

The bell shown in Fig. 3 is a polarized bell. *N'S'* is a permanent magnet; *c* and *c'* are soft iron cores connected by the yoke *y*, also of soft iron, and on which the bell caps are mounted. The bell hammer is rigidly fixed to *A'*, which is so pivoted that its ends may move freely toward *c* or *c'*, according to which is the stronger magnet. The alternating current from the magneto periodically strengthens and weakens the magnetism induced in *c* and *c'* by *N'S'*, so that one end of *A'* is alternately attracted more strongly than the other, which makes the hammer strike alternately the two bell caps.

The bell and the armature winding are connected in series with the line (see Fig. 5). Hence any ringing current coming from the line, meets the resistance of the magneto. This resistance, which is appreciable, would weaken the ringing current considerably. To remedy this, special devices are provided which short-circuit the armature when the magneto is not in use.

Fig. 4 illustrates this. Here, the short-circuit is made between *p* and *p'* by the contact at *d* which is held in place by a spring. As soon as the crank *C* is operated, *p'* is pressed away from *p* by means of another spring. When *C* has ceased to turn the short circuit is re-established.

III.

Enough has been said to make plain along what lines certain fundamental electrical principles have been utilized in telephony. By way of emphasis, a brief summary will prove useful.

Prof. A. G. Bell is given the credit for constructing the first successful telephone instrument. His success was due in a great measure to the fact that he realized fully the importance of a basic principle announced at the time by Lord Kelvin, viz., that " . . . If electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of its current must vary continuously as nearly as may be in simple proportion to the velocity of a particle of air engaged in constituting the sound." The make-and-break principle used by many experimenters could not be made to meet the above requirements. To get a current which would vary continuously and in simple proportion to the velocity of sound, Bell made use of two electrical principles (as explained under Fig. 1): (1) that, if the intensity of a magnetic field inclosed by a conductor be in anywise varied, a corresponding varying current of electricity will flow in said conductor (transmitter), and (2) that, if a permanent magnet be under the influence of a varying current, this current will, according to its direction, increase or diminish the inherent attractive force of said magnet (receiver).

Bell's instrument proved a striking success (its essential features being embodied in present day receivers). It lacked, however, the capacity to generate a current of sufficient strength to contend with high-resistance lines. To overcome this defect the carbon transmitter, based on the theory of varying pressure (as explained under Fig. 2), was devised by Edison, whose ideas are embodied in present day transmitters.

It has been pointed out that a variation of resistance will produce a variation of current. That this is the general principle underlying the transmission of speech may now be thoroughly appreciated by rereading the text pertaining to Fig. 2.

A general assembly circuit embodying all the necessary features of an elementary telephone system is shown in Fig. 5. Here, if *M* wishes to talk to *N*, the crank of the generator *G* is turned (switch hook *H*

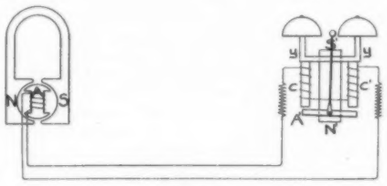


Fig. 3

down); ringing current passes out on the line, through switch hook *H'*, to the bell *B'* and back to its source (*G*) by way of the shunt (Fig. 4) attached to *G'*. *B* and *B'* ring at the same time. *M* now takes his receiver off the hook and waits for *N* to answer.

If *O*, who is in the immediate vicinity, wishes to establish telephone communication with both *M* and *N*, an instrument is placed on his premises with separate pairs of wires going to the respective instruments of *M*, *N* and *O*. When there are more than two or three instruments, some form of sliding contact lever key is also provided at each instrument for placing any two stations in circuit. Fig. 6 indicates the form such lever key arrangements may take. With the key in its normal position, *M* is always in circuit with every station in the system. If *M* wishes to call, say *L*, the key must first be moved to the position indicated by the broken line. Contact is thus broken at *n*, *o*, *l*, and *q*, and *M* is in circuit with *L* only.

It is along lines similar to the above that what is known as an "Intercommunicating System" is established. Such systems, in a variety of forms, are in common use in offices, factories, hotels, etc., where the number of stations does not exceed say twenty-five. A greater number than this necessitates such an amount of wiring and complication of circuits as to make the system both expensive and cumbersome.

IV.

Considerations of a technical, commercial and practical nature have made the "Central Station" method the only successful one for handling a large number of telephone stations. Here, every telephone station has but two wires which terminate in a central office, where an operator is provided with suitable devices for placing any two stations in circuit.

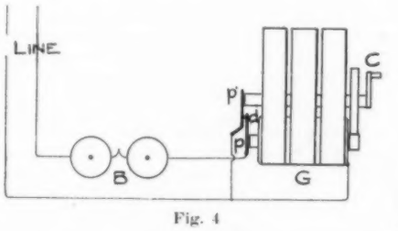


Fig. 4

Central offices may be divided into three general classes:

1. Automatic.
2. Magneto.
3. Common Battery.

Automatic central offices aim to do away either entirely or in part with the services of operators. Here, the central office equipment is very complicated and does not permit of sufficient flexibility. At the present time there are comparatively few automatic systems in operation.

Magneto central offices are not subject to the above objections, but here, the subscriber's equipment (which is as indicated under Fig. 5) entails an outlay of dead capital (local battery and generator), the maintenance cost per instrument is excessive (battery needs frequent attention), and the subscriber is

* *The Sibley Journal of Engineering* of Cornell University.

required to perform duties which are burdensome and inconvenient (holding switch hook down and operating hand generator to "ring" central). Magneto systems are being rapidly replaced by common-battery systems, which though by no means perfect, yet possess those elements which stand for convenience, electrical efficiency, reliability, economy, and flexibility.

The basic elements of a common-battery system are shown in Fig. 7. The subscriber's equipment consists of a transmitter, receiver, induction coil (not shown), switch hook, polarized bell, and condenser. The subscriber's pair of wires terminate at the central office switch board in what is termed an answering jack. The subscriber's lamp with its battery is connected to the answering jack springs as shown. Normally the lamp circuit is open on ac-

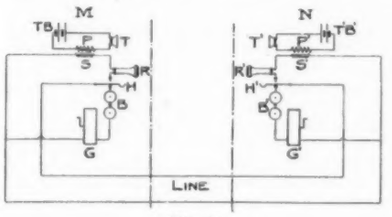


Fig. 5

count of the condenser which is a bar to the passage of unvarying currents.

The common battery or talking battery is wired in multiple between the answering and calling cords. Each pole of the battery is connected to these cords through a divided repeating coil, one limb of each cord being connected to one of the four windings of the repeating coil. The operation of a transmitter in circuit with either cord will produce a varying current which will act inductively, through the repeating coils, upon the other cord.

Thus, if *A* wishes to speak to *B*, he takes the received off the hook and unconsciously makes contact at *d* which lights his central office lamp. On seeing the light, the central office operator inserts the plug of the answering cord into *A*'s jack, and puts her telephone instrument in circuit with *A* by pressing the talking key. (As an incident to the insertion of a cord plug into a jack, the jack springs are pressed away from the lamp circuit contacts, thus putting the lamp out.) When *A* tells the operator that he wants *B* she inserts the plug of the calling cord into *B*'s jack and presses the ringing key. This sends alternating current out on the line, through the condenser (which is no bar to alternating current) and the bell. When *B* takes his receiver off the hook, communication between *A* and *B* is established.

When *B* is transmitting, the windings *c'c'* will operate as the primary windings of a transformer, of which the secondary is formed by *cc*. The variation of current produced by *B*'s transmitter will act inductively through the repeating coils, and produce a corresponding variation of current in *A*'s circuit, thus actuating his receiver.

V.

There are few industries in the United States which have made more rapid progress than that of telephony. The first successful telephone instrument was introduced by Prof. Bell in 1876. Early in 1877 the manufacture of telephone instruments took definite form, and by the end of the year there were about 60,000 instruments in use. This enormous progress (although the percentage rate of increase has been greatest in the past few years) has been continuous.

The report for 1907 shows that the Bell system has about four million subscribers and that the actual value of Bell plants and working capital is $589,000,000. Gross earnings for the year amounted to $120,000,000. The number of local messages averages eighteen million daily; the number of long distance messages nearly a half million daily.

The above figures would perhaps be enlarged once over, if reports from all the independent companies were available.

The figures would tend to indicate that with the great capital invested, the number of persons employed must be enormous and that, therefore, telephony as a field of effort must rank among the leaders.

The California ground squirrel is costing the country millions of dollars because of its destruction of grain, fruits, and nuts, and its tunneling in irrigation embankments. In May, 1910, it caused a break in the Turlock Canal in Stanislaus County which cost $25,000 to repair, in addition to the loss of the use of the water, estimated at over half a million dollars. Still more important is the fact that the ground squirrel has become plague-stricken and unless vigorous measures are used for its destruction the disease may become endemic as it is in India among certain of the native rodents. There is danger that the disease may be communicated to human beings and spread to other States. The most effective means of destroying the ground squirrels has been found to be whole barley coated with a starch solution holding strychnine in suspension. With this preparation the squirrels may be practically exterminated over large areas at a cost of from 2½ to 6 cents an acre, depending on their abundance. This preparation may be safely employed in pastures, on sheep ranges, and along public highways. The poison should be administered before the breeding season.

The Corrosion of Iron

WE have no intention of troubling our readers by jejune remarks on the importance of the matter on which we indite. The point of interest for engineers is the cause of the corrosion which destroys their structures, for the reason that, the cause being found, remedies may be provided.

Hitherto there have been two rival schools, with their respective scholars, and an academy with a scholiast at its head, which and who are now dismissed. The schools are known as the carbonic acid and the electrolytic schools, and, put briefly, their doctrines are these: The carbonic acid exponents believe that the rusting of iron is conditioned by the inter-action between the metal and the oxygen of carbonic acid, which, in the presence of water, forms ferrous carbonate, this being decomposed by further oxygen to form ferric hydroxide, and to liberate carbonic acid, which is the evil emissary laying the iron open to attack. The upholders of the electrolytic theory maintain that the intervention of carbonic acid is an accident, and unnecessary as a mode of explanation. They hold that pure iron has in itself a solution tension—in plain words, a tendency to dissolve—in pure water, just enough to cause it to displace the hydrogen of that water, to form a solution of ferrous hydroxide, and to produce rust when this solution is exposed to oxygen—from air it may be. Experiments are given by both protagonists diametrically opposed. The believer in the electrolytic theory states categorically that he has been able to dissolve pure iron in pure water; his opponent shows with great exactitude that pure iron is unattacked by pure water even in the presence of oxygen, but on the incursion of the merest trifle of carbonic acid corrosion occurs and proceeds. Honest thanks are due to both these honest workers, and from the conflict of their opinion something useful may be picked.

It is a fundamental fact that in a system composed of the pure substances, iron, water, and oxygen, the oxidation of the iron should take place, because the energy of the system is thereby degraded. It is also known that to upset the equilibrium of such a system which may be unstable, some *quartum*

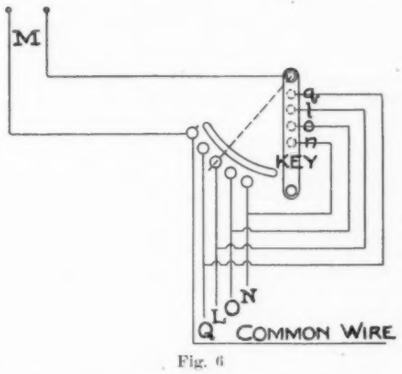


Fig. 6

quid may be needed. This, in the present instance, may be termed an electrolyte. Water, when as pure as the chemist can secure, is so nearly a non-electrolyte that its influence may be dismissed. But any ordinary water, condenser water, and, still more, the natural water which in practice commonly comes into contact with iron, contains abundance of electrolytes. Pure iron is, no doubt, homogeneous in the fullest sense, but no one who has looked at the polished surface of a piece of commercial iron—and *a fortiori* steel—under the microscope, would hesitate to pronounce it miscellaneous in texture. As neither pure iron nor pure water ever come together in practice, it may be pretty safely assumed that these two materials in the presence of oxygen will suffer ordinary corrosion, and in this respect the electrolytic advocates are right, although their experiments were designed to avoid such *contretemps* as commercial iron and common water. *Per contra*, the carbonic acid dialecticians have proved their point almost to the hilt by working with precautions bearing the most remote relation to those obtaining in a boiler. When the sides are balanced, and when all proper allowance is made for the serious difficulties of experiment—difficulties which can scarcely be appreciated by any who has not himself encountered them—the matter according to our present knowledge may be summed up thus.

Commercial iron, including all forms of steel, is a heterogeneous body. Ordinary water contains a variety of salts which are electrolytes. In the presence of oxygen the iron will be oxidized, as thermochemical considerations require. The rate of oxidation will depend jointly on the degree of heterogeneity of the iron, and on the amount and completeness of dissociation of the electrolytes. But as in every natural water carbonic acid exists, and as it can act as

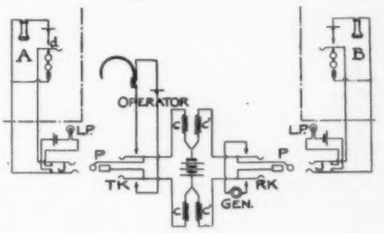


Fig. 7

a labile acid, uniting with ferrous hydroxide, and being expelled from that combination by oxygen (ferric hydroxide being formed) again to take up its role as a constituent of ferrous carbonate, it is preeminently fitted to serve as a destroyer. Iron in the ferric state is sufficiently basic to hold most other acids, but carbonic acid it cannot hold, and thus it turns the emissary back to do further mischief. In practice both causes of destruction are at work, the heterogeneity of the iron, and the liability of the carbonic acid—the presence of an electrolyte being understood.

Formulation of our present knowledge and description of its foundation is easy, but what about the remedy? It is best to say at once that none exists. As long as the heat of combination of iron with oxygen remains at 68,000 cal., and as long as these two elements are in contact with one another, so long will iron rust, provided a few necessary conditions occur, and these are so ordinary that their existence may be assumed. In special cases it is possible to prevent the corrosion of iron by making it "passive," or by making it electronegative, but these are rare enough to be put as instances, and not as examples. In most cases the engineer has already decided that the provision of a skin which shall block the passage of oxygen to the iron is the best mode, but as his idea of a skin usually resolves itself into one of paint, the outcome is generally poor. Certainly it may be improved by the use of more rational preservatives than paint, such as tar applied as hot as it can be got upon the structure. But this is scarcely a help in protecting the inside of a boiler; and if it be admitted, as it must be admitted if any fragment of our knowledge is right, that the destruction of a clean, unprotected boiler of any sort fed with clean, ordinary water is certain, then thankfulness may be felt that clean, ordinary water commonly provides its own protection for the boiler in the homely form of scale.

There is no royal road. Iron is won by the expenditure of fuel, and is potentially a combustible. Wherever it meets oxygen it will endeavor to unite with it. The rate of union is neither here nor there; the tension making for union remains. As that tension is elemental and invincible, the only means for its frustration is a severance of the two bodies by an impermeable septum, and as our friends the electrochemists have given us such valuable help in this matter, we crave their aid for its provision.

Wedgewood Ware is a peculiar glazed or unglazed earthenware goods, first made in England by the potter Josiah Wedgewood and named after him. In coloring Wedgewood ware in the mass, the Jasper ware, for instance, consisting of:

Heavy spar	150	40	30	50	32	160
Kaolin	35	..	..	15	10	60
Blue clay	45	20	12	35	25	90
Fire clay	35	..	3	10	8	40
Gypsum	6	..	..	..	1	8
Cornish stone	50	20	20	..	7	..
Bone ash	..	..	..	25	..	..

Add coloring metal oxides: Blue, 0.5 oxide of cobalt; dark green, 1 part chromic oxide; blue green, 0.3 chromic oxide and 0.3 cobalt oxide; light green, oxide of nickel; bluish green, oxide of copper; yellow, antimony yellow; brown, in place of flux, add to the plastic clay about 0.33 of calcined ochre (iron dross) and about 8 parts of manganese.

What Electrochemistry is Accomplishing—II*

Modern Methods and their Results

By Joseph W. Richards

Concluded from Supplement No. 1830, page 51

III. Electric Furnaces.

Electric furnaces are furnaces in which the necessary heat or degree of temperature is produced or attained by means of electrical energy. The electric current is used in these furnaces solely for its heating or thermal effect, and either alternating or direct current may be used, but alternating is preferred because of its easier generation and management, capability of being procured from transformers, and absence of electrolytic effects.

Electric furnaces render remarkable and highly valuable service to the chemist and metallurgist, for two distinct and unique capabilities; they can generate heat within themselves without the use of combustion and the consequent products of combustion to complicate the working of the furnace, and they can besides, if desirable, produce temperatures absolutely unapproachable in furnaces using fuel, and thereby enable the carrying out of operations only possible at these extremely high temperatures. The upper limit of electric furnace temperature is simply the volatilizing point of carbon, the temperature at which the material of which the lining of the furnace is made, is boiled away. This is about 3,700 deg. C. or 6,692 deg. F. The simple statement that this is three times as high as the melting point of cast iron, may give some notion of the enormous temperature here at one's command. Besides high temperature, the efficiency of application of electrical heat to the useful purpose is usually high, in many cases 50 to 75 per cent of all the heat developed can be usefully applied, as against 5 to 50 per cent utilized in fuel-fired furnaces. The heating value or thermal equivalent of the electric current is perfectly definitely known; one kilowatt-hour will furnish 860 calories (3,400 B.t.u.), which if applied usefully at 100 per cent efficiency would bring to boiling and convert into steam 1.35 kilogrammes (3 pounds) of water, or bring to melting and melt about 3 kilogrammes (6.6 pounds) of cast iron, or 2.5 kilogrammes (5.5 pounds) of steel.

Artificial graphite is a product particularly electrochemical in its manufacture. Your fellow-townsman, Dr. E. G. Acheson, has practically created this industry and his name sticks to the product—Acheson graphite. No temperature but that of the electric furnace can convert the ordinary amorphous carbon, containing small amounts of foreign substances, into pure, soft, homogeneous, unctuous graphite. The purity of the product and its quality has even surpassed the artifice of Mother Nature herself. Whereas before, graphite in small scales was laboriously gathered from Ceylon and Siberia, and with great pains worked up into graphite articles, now the articles are simply molded in ordinary impure amorphous carbon, and converted through and through, retaining their shape, into finished and complete graphite articles. What this highly pure product is going to do for lubrication, for annihilating the friction of the world's machinery, perhaps only a few suspect and only Mr. Acheson knows. You will all know more about this soon, and everyone of you who uses machinery will profit by it. Meanwhile, in another direction, probably half the electrochemical industries now operating are beneficiaries of this invention, using artificial graphite anodes in electrolytic operations or as electrodes in electric furnaces. The electrochemical industry in general has been most wonderfully helped by this one electrochemical process.

Carborundum stands for a large industry, centered at Niagara Falls, and founded also by Mr. Acheson. Twenty years ago the name was not in the dictionary; now it is known all over the world as the most efficient abrasive material in use. First produced just across the Monongahela, in a little furnace as large as a cigar box, and sold for polishing diamonds at many dollars per ounce, it is now made by tons in electric furnaces of 2,000 horse-power capacity, and competes successfully with such common natural abrasives as emery and common sand. And in fact, common silica sand, the most abundant material on earth, with common carbon, like coke, furnish all the ingredients necessary for the furnace to work upon to produce SiC, silicon carbide. Mr. Acheson not merely founded another new industry, but he discovered a new chemical compound; he has enriched science, promoted industry, and created new instruments of service; no wonder that his scientific friends have showered on him honors—the Rumford Medal, the Perkin Medal, and two years ago the presidency of this Electrochemical Society.

Silicon is the metal whose oxide is silica sand, and is by far the most abundant metallic element on earth. Up until very recently it was to be seen only in chemical museums, costly and useless—a chemical curiosity. Now Mr. F. J. Tone, one of Mr. Acheson's former lieutenants, is producing it by the ton and selling it by the carload, at a few cents per pound. The chemical world has found uses for it, large uses, such as in solidifying steel, making good copper castings, reducing other metals from their oxides, chemical "pots and pans," etc. This illustrates again the variety of the achievements of electrochemistry. Here is a new material furnished the world at a low price and all sorts of workers are finding all sorts of advantageous uses for it. The electric furnace makes it from simply sand and carbon, with electric energy, and plus considerable "brains."

Calcium carbide is the product of another American invention. The name was scarcely in chemical books, and the purveyors of the rarest chemicals did not have it on their lists, when Mr. Thomas Wilson, trying to make something else in the electric furnace, made this compound from ordinary lime and carbon, and started an electrochemical industry which has spread all over the civilized world. I am almost tempted to say that there is a calcium carbide works everywhere but in Pittsburg, but that would really be an exaggeration, and I will not say it. The best thing about calcium carbide is that it is easy to make; the raw materials may be found almost everywhere, and wherever power is cheap a flourishing calcium carbide industry may be built up. The curious thing about it is that its chief use is based on destroying it, acting upon it by water and forming acetylene gas. How great a boon acetylene gas has been to the bicyclist, automobilist, for lighting trains, isolated houses, stations, and towns, needs no recital before this audience; but the value of acetylene as a means of welding with the blowpipe is only commencing to be appreciated. Acetylene welding is a convenience which owes its existence entirely to the electrochemical production of calcium carbide, and the iron and steel and other metal industries are being greatly helped by its use.

Titanium carbide is not as familiar as calcium carbide. It is made in a manner similar to the production of carborundum, using titanium oxide (rutile) and carbon. It has no uses similar to calcium carbide, nor any like silicon carbide. But electrical engineers have discovered that as arc light tips or electrodes it gives the most efficient arc light yet discovered, with a light efficiency running up to 3 candle-power per watt of electrical energy. This is probably 50 per cent of the theoretically possible conversion of electrical energy into light energy, and is doubly as efficient as has ever before been attained. What this means for street lighting everywhere is difficult to realize; perhaps the best and most easily understood comparison is to say that the titanium carbide arc lamp is to the ordinary arc, as the tungsten filament incandescent lamp is to the carbon filament lamp; you will all grasp the scope of that statement. With acetylene lighting on one hand, and titanium arc lighting on the other, we need say no more about the influence of electrochemistry on modern illumination.

Phosphorus. I stated before that the potassium chlorate on safety matches was all being made electrochemically. We can say practically the same of phosphorus. The electric furnace enables us to distill phosphorus much more easily and safely from the natural phosphates, than the older chemical methods. Calcium carbide gives us acetylene gas, and another electrochemical furnace gives us the phosphorus to "strike the light."

Ferro-alloys are alloys of iron with the more expensive metals, used in manufacturing steels of various kinds. Ferro-manganese is used in practically all steel, ferro-silicon is used in almost all. Ferro-chromium, nickel, tungsten, molybdenum, boron, uranium, vanadium, are some of the alloys used to make the special alloy steels, such as find great use in rapid tool steel, automobile axles, armor plate, gun steel, etc. These alloys are of great importance to the steel industry, and are made almost exclusively in electric furnaces. The industry has flourished most in countries having cheap power, such as among the French Alps, and the importations into this country have been on a large scale. Fortunately, we are commencing at Niagara Falls, in Virginia, and in Canada, to supply ourselves with these necessities of the steel industry, and we may look forward to a steady and large domestic development of this industry. Within a few miles of this hall, a small electric furnace is now at work making ferro-tungsten to go into high-class, expensive steel. Pittsburg is going to take its share in the running of this particular electro-metallurgical industry.

Pig iron would seem to be about the last item to find a place in an address upon the electrochemical industries. But the truth must "out": electric furnace pig iron is now being made, and made and sold at a profit. We will hasten to admit that the furnaces are small, that they are in California and Sweden, where fuel is expensive and power is cheap, that a great deal of money has been sunk in bringing them to their present condition; but after all has been admitted, the fact remains that electric-furnace production of pig iron is not a chimera, but an accomplished fact. Pittsburg has been able to boast that she "could manufacture a ton of pig iron and put it down anywhere in the world cheaper than it could be there produced." That may be *still* true *of the kind* of pig iron which Pittsburg is able to make, but there are grades and qualities of pig iron (Swedish charcoal pig iron, for instance) which are still imported into this country and sold at double the price of our domestic pig iron. And, in the country where that charcoal pig is slowly, laboriously and skillfully made, the electric shaft furnace is able to compete with the charcoal blast furnace in producing this high quality pig iron. Dr. Haanel, of the Canadian Department of Mines, has in a recent report given us the most reliable information about the running of this furnace. The construction is peculiar, and still somewhat experimental, the full power for which the furnace was designed has not yet been available for running it, the workmen are new to their tasks, the overseers are still learning, the irregularities in the running are not yet all overcome, and many of the minor details are yet being adjusted. The furnace is still, in brief, decidedly in the formative or experimental stage. Yet, notwithstanding, Prof. Odelstjerna, one of the most expert of Swedish metallurgists, states that the cost of production is $1.50 per ton less than in the Swedish blast furnaces. If that is true now, it needs little gift of prophecy to figure out at least $2.50 per ton saving when the furnace is properly run. Three similar furnaces of greater capacity, 2,500 kilowatts each, are to be erected in Norway; three similar ones are to be put up at Sault Ste. Marie, Canada. These are only the forerunners, we may be sure, of dozens or perhaps even hundreds which will be built and operated within the lifetime of most of this audience. The time at our disposal forbids me describing these interesting furnaces; I can only refer you to Dr. Haanel's interesting reports and to the transactions of this society, particularly to our volume xv. One surmise of my own I will, however, take time to mention: I have predicted that this electric furnace pig iron, made without the admittance or use of air blast, will be far superior to ordinary pig iron for conversion into steel, because of the absence of oxygen or, particularly, of nitrogen. *Time* will test this prediction, too.

Electric steel is at present a topic of absorbing interest and great potentialities. It was primarily a competitor of the most expensive kind of steel—crucible steel. It was first made commercially in 1900, by Mr. F. A. Kjellin of Sweden, by melting together in an electric furnace the same high-grade materials which are usually melted down in crucibles to form crucible steel. The product was made equal in quality to crucible steel, it was produced in lots of a ton or more at a melt, of very satisfactory uniformity, and with cheap water power to furnish electricity the cost was considerably below that of crucible steel.

The steel melting pot or crucible is a siliceous vessel, holding about 100 pounds of steel, lasting only a few heats, and lifted in and out of the furnace by manual labor. The consumption of fuel to get the required melting heat is wickedly wasteful; not over five per cent of the heat-developing power of the fuel used is efficiently utilized as heat in the melted steel, and the actual proportion is usually less than half that much. The cost of labor, crucibles and fuel is excessive, and to this must be added the high cost of the pure material which must be used—practically the purest iron which can be made.

The electric furnace is changing all this, rapidly in continental Europe, slower in Sheffield, and still

* An address delivered at the Seventeenth General Meeting of the American Electrochemical Society in Pittsburg, Pa., and printed in the Transactions of the Society.

slower in America; but the change is spreading surely and inevitably. Real crucible steel will soon be a thing of the past, supplanted entirely by electric furnace steel of equal quality, made and sold much more cheaply.

The electric furnaces used are of almost all types. The induction furnace was developed commercially by Kjellin in Sweden, improved, enlarged and greatly developed by his associates in Germany, combined with the Colby pattern in America, and still further modified by Hiorth in Norway. Thirty-six of these furnaces, the maximum capacity being one at Krupp's works at Essen, 8½ tons at a charge, are now built or building. The American Electric Furnace Company is organized to push their building and operation in America. The arc radiation furnace was developed by Major Stassano, an Italian artillery officer. It melts by heat radiated from powerful electric arcs. Several of these are in operation in Europe, and a gentleman managing one of the large American steel companies, who has just returned from an inspection of the different electric steel furnaces operating in Europe, tells me that he considered the Stassano furnace as doing the best work all around, of all the furnaces he saw in operation. I have seen this furnace operating smoothly and regularly, in Turin, producing steel for castings which were being sold in competition with open-hearth and Bessemer steel castings in the open market. The single arc furnace is best illustrated by the Girod furnace which is built like the body of an open-hearth furnace with the electric current entering the bath by carbon electrodes suspended above it and springing arcs to it while the current leaves the bath through metallic conductors passing through the saucer-shaped hearth below the level of the metallic surface. These furnaces work with great regularity, and a large number are operating in Europe in capacities up to 12 tons each. I am informed that the Krupp works at Essen has just contracted to put in five of these of the 12-ton size, which would confirm statements made to me by my European friends that this furnace is working the best of all the electric steel furnaces now operating in Europe. The double arc furnace, of which the Heroult furnace is the most familiar type, works with two arcs in series, the current entering the bath and leaving it also through electrodes suspended above it. The general style is that of an open-hearth furnace with electrodes passing through the roof. The current used is roughly 100 kilowatts per ton of steel capacity, and the largest so far operated is 15 tons. A three-ton furnace of this type was seen by you at the Firth-Stirling Steel Works at Demmler, yesterday, producing crucible-quality steel. The U. S. Steel Corporation has acquired licenses to operate the Heroult furnace, and has already two 15-ton furnaces in operation. Without doubt, the Heroult furnace is at the present time the most popular and successful electric steel furnace in the United States. I have not time to more than name the Keller, the Hiorth, the Harmet, the Frick—all of which are operating at this present moment, in Europe.

There are other ways of making steel than the crucible method. Bessemer steel is the cheapest, and open-hearth steel is next best. These two varieties grade into each other in quality, but between open-hearth and crucible steel there is an enormous gap in price and in quality which is destined to be bridged over by intermediate qualities of electric steel, as it becomes cheaper and is manufactured on a larger scale. This will soon become one of the large uses of the electric method, occupying a field peculiarly its own. It will enable steel manufacturers to supply steel better than the best open-hearth product at less than the price of crucible steel. I need not enlarge upon the advantages of this to a Pittsburg audience.

There are also varieties of methods of manufacture of steel, aside from the melting together of highly pure materials as in the crucible method, which are equally available in most types of the electric furnace. The Bessemer converter takes liquid pig iron as it comes from the blast furnace and by rapid oxidation by air blast converts it into steel. Mr. Heroult has tried to combine the Bessemer converter with the electric furnace, in one apparatus, the idea being to first oxidize the metal by air blast and then to finish it while electric current supplied the necessary heat. I have no information that this combination furnace is anywhere in successful operation, but the equivalent of the same operation performed first in the Bessemer converter and then on the blown metal transferred into an electric furnace for finishing, is already in regular commercial operation at the South Chicago Works of the U. S. Steel Corporation. I have had the privilege and pleasure, thanks to Mr. Heroult, of studying that operation, in company with Mr. Heroult and the editor of Metallurgical and Chemical Engineering. You may find a description of the process in the April number of that journal, so I will not repeat it here—except so far as to say that 15 tons of the product of the Bessemer blow, oxidized to the extent usual in the Bessemer converter, was kept melted less than two hours on the basic hearth of the electric furnace, treated with two different slags to refine it from phosphorus and sulphur, deoxidized or "dead-melted," and then poured into ingots of steel intended for axles. The steel produced was of better quality than the usual corresponding open-hearth metal, and was produced at slightly less total cost. This combination process bids fair to give a new lease of life to the declining Bessemer steel industry; its economic importance is evident.

The open-hearth steel furnace is, at present, the most important of the methods of manufacturing steel —"tonnage steel." It makes steel from pig iron and scrap of proper quality, or from pig iron and iron ore (mill-scale), or from pig, scrap, and ore. It makes its best steel on silica hearths from high grade material low in sulphur and phosphorus, and its cheapest steel on basic hearths from almost anything. The electric furnace can do any or all of these things, and, as a general proposition, produce better steel from given materials than the open-hearth furnace. Under what circumstances it will pay to use the electric furnace instead of the open-hearth furnace would take at least one lecture to discuss; we will not go deeply into it here. In Europe, countries which have very cheap water power, around $10 per horse-power year, and fuel costing $4 to $6 per ton, are finding the electric furnace the cheaper; with power costing $20 and coal $5, the two are about on equal terms; in Pittsburg, with power at $30 and coal at $1, the open-hearth furnace is by far the cheaper for producing such steel as it can produce. However, even here, the combination of Bessemer and electric furnace is possibly cheaper than the all open-hearth process; the combination of open-hearth and electric furnace process is quite possible and practicable, to produce crucible-quality steel on a large (tonnage) scale, and the combination of the open-hearth and electric furnace into one furnace is not only a possible combination, but is actually being "tried out."

The latter idea is to take an open-hearth furnace, and to place electrodes in the roof. The furnace is run as an ordinary open-hearth furnace, with the electrodes withdrawn; and at the close of the open-hearth heat, gas and air are shut off entirely, the electrodes lowered into proximity to the bath, and the heat finished as an electric furnace heat. The idea is sound and practicable, and will result in the production of better steel than can be obtained from any open-hearth furnace, at but a slight advance on the cost of the open-hearth steel, say, $2 to $3 per ton.

As to the capacity for enlargement of electric steel furnaces, they started out to duplicate the crucible steel process, producing 100 pounds of melted steel at a heat, and in eight years have risen to 15 tons capacity. In Europe, an electric calcium carbide furnace of 18,000 kilowatts, capable of producing 200 tons of carbide daily, is in practical operation. A furnace of like power capacity could be built to make steel, and would be a 200-ton steel furnace or larger. We can therefore say with assurance, that with a little more experience and experiment, electrometallurgists will be able to furnish the steel maker with electric steel furnaces as large as are wanted—up to 200 tons' capacity if desired.

Polonium

POLONIUM was the first of the active substances separated from pitchblende residues by Mme. Curie. Various methods of concentration were devised by her, with the result that preparations of polonium mixed with bismuth were early obtained many thousand times more active than uranium. Marckwald later separated from 15 tons of pitchblende about 3 milligrammes of intensely active material which he called radio-tellurium, since it was separated initially with tellurium as an impurity. By dipping a copper plate into a solution of this substance, he obtained a deposit of weight not more than 1/100 milligramme, which was far more active than an equal weight of radium. It was soon recognized that this preparation was identical with polonium, for it gave off the typical α radiation, and had the characteristic rate of decay of that substance. Unfortunately, Marckwald was not aware at the time of separation of the great importance of testing whether lead appeared as a product of transformation of polonium. Before such an experiment could be made, the polonium to a large extent had been transformed.

Polonium is one of the numerous transition elements produced during the transformation of the uranium-radium series. It is half-transformed in about 140 days, emitting α particles during the process. Rutherford showed in 1904 that polonium was in reality a transformation product of radium itself. Radium at first changes into the emanation, and then successively into radium A, B, C, D, E, F, radium F being identical in all respects with the polonium directly separated from a radio-active mineral. When the radium emanation is allowed to decay in a sealed glass tube, the walls of the tube are coated with an invisible deposit of pure radium D, radium E, and radium F, but the amount of the latter to be obtained in this way is far too small to be weighable.

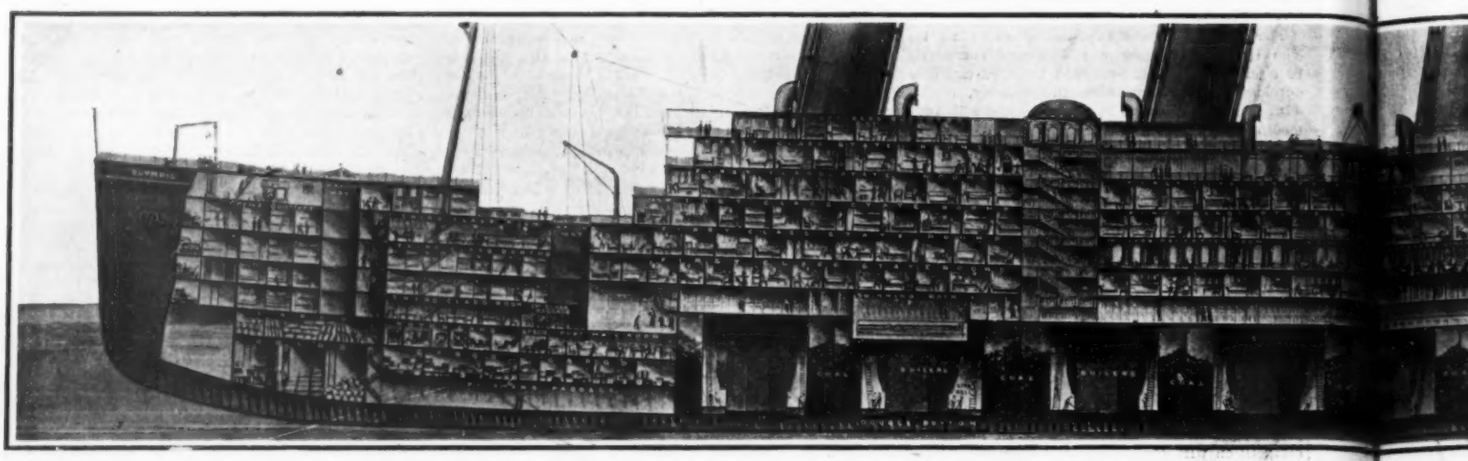
The amount of polonium present in any radio-active mineral can easily be calculated. Since the radium and polonium (radium F) in a mineral are in radio-active equilibrium, the same number of α particles are expelled from each per second. Since polonium is half transformed in 140 days and radium in 2,000 years, the former breaks up 5,000 times faster than the latter. The maximum amount of polonium to be obtained from a mineral is in consequence only 1/5,000 of the amount of radium. In 1,000 kilogrammes of pitchblende containing 50 per cent of uranium, there are present 170 milligrammes of radium. The weight of polonium is about 1/5,000 of this, or about 1/30 milligramme. It is thus obvious that to obtain 1/10 of a milligramme of pure polonium, several tons of high-grade pitchblende must be worked up. The most natural source of polonium is radium D (radio-lead), which grows polonium and has a period of half transformation of about twenty years. Since polonium breaks up about 5,000 times faster than radium, its activity, weight for weight, should be about 5,000 times greater than that of radium. There is nothing surprising in this, for the radium emanation has an activity about 200,000 times that of radium, while radium A (period three minutes) must have an activity 400 million times that of radium itself. Since the radiation from polonium is entirely in the form of α rays, it is to be expected that the radiation from it would show chemical and physical effects identical with those observed for pure emanation, the only difference being that the products of the latter emit β and γ rays as well.

Apart from the interest of obtaining a weighable quantity of polonium in a pure state, the real importance of the present investigations of Mme. Curie lies in the probable solution of the question of the nature of the substance into which the polonium is transformed. This problem has been much discussed in recent years. Since polonium emits α particles, one of its products of decomposition, as for all the other α-ray products, should be helium. The production of helium from a preparation of polonium has been observed by Rutherford and Boltwood (Manchester Lit. and Phil. Society, November 30th, 1909), and also by Mme. Curie and Debierne in their present experiments. Boltwood several years ago suggested that the end product of the radium series was lead, and has collected strong evidence in support of this view by comparing the amount of helium and lead in old radio-active minerals. Since polonium is the last of the active products observed in the radium series, it is to be expected that polonium should be transformed into helium and lead, one atom of polonium producing one atom of helium and one atom of lead. This point of view receives additional weight from consideration of the atomic weight to be expected for the end product of radium. Since in the uranium-radium series, seven α particles, each of which is an atom of helium of atomic weight four, are successively expelled before radium F is reached, the atomic weight of polonium should be $7 \times 4 = 28$ units less than uranium (atomic weight 238.5). This gives an atomic weight of polonium of 210.5, and after the loss of an α particle, a final product of atomic weight 206.5—a value very close to the atomic weight of lead.

It is a matter of very great interest and importance to settle definitely whether polonium changes into lead. The evidence as a whole has long been in favor of that supposition. The outlook is very promising that the experiments of Mme. Curie and Debierne will settle this question conclusively. No doubt an interval must elapse to allow the polonium to decay before the final examination of the residual substance can be made.—*Nature.*

In a report by the French Consul-General at Rotterdam, it is stated that 75 vessels of large and medium dimensions, aggregating 72,980 tons, were built in Dutch yards last year, against 76 vessels, of 63,806 tons, in the year 1908. The average measurement of the vessels built last year was 973 tons, whereas in 1908 it was only 850 tons. River boats and small seagoing craft were also constructed to the number of 799, and aggregating 150,753 tons, the small vessels built in 1908 totaling 683 boats and 112,873 tons. A good number of vessels were built for foreign account last year, namely—for Germany, 60,760 tons; for Belgium, 9,382 tons; for Great Britain, 4,279 tons; for Argentina, 3,160 tons; for Brazil, 1,010 tons; other items making up a total altogether on foreign account of 97,996 tons.

The World's Greatest Ship—The Olympic



The new White Star liner "Olympic" which was launched from the famous yard of Harland & Wolff at Belfast in October last is far and away the largest vessel ever built, her tonnage being 45,000 tons, contains 888½ feet; beam, 92½ feet; depth (from keel to main deck rail), 62 feet; and her tonnage displacement is 60,000. Her huge hull, divided into thirty water-tight compartments, contains will propel her at a speed of 21 knots. In equipment also she will surpass anything afloat as can be seen from this diagrammatic picture of her interior.

THE WORLD'S GREATEST SHIP

THE launching of the White Star liner "Olympic" at Belfast on October 20th, marked a new advance in naval architecture. Not only is the "Olympic" the largest vessel that has ever been built, but her propelling machinery is of a type that has never been installed on a vessel of such dimensions. After the success of combined turbine and reciprocating machinery in the "Laurentic," it was decided to equip the new steamer with both types of engines and with triple screws.

The "Olympic" outwardly resembles the "Mauretania" of the Cunard Line. She has four elliptical funnels, each 28 feet in diameter. Her length is 888½ feet; her breadth over all, 92½ feet; her breadth over boat-deck, 97 feet; her height from the bottom of her keel to top of her captain's house, 105½ feet, and to the top of the funnels, 175 feet; her freeboard is somewhat greater than the "Mauretania's," being about 52 feet at the top, 45 feet to the level of the main deck, 62 feet to the boat-deck amidships, and 42 feet at the stern. She may be distinguished from other four-funnel ships on the high seas by a single pole-mast forward of the bridge. The "Olympic" has a maximum draft of 37½ feet, on which she displaces about 60,000 tons, as against a displacement of 45,000 on the same draft for the "Mauretania."

Despite her size, her engines will develop 45,000 horse-power, sufficient to maintain the minimum speed of twenty-one knots, for which she has been designed. The combined reciprocating and turbine engines are so planned that two reciprocating engines will drive the wing propellers, the exhaust passing into a low-pressure turbine driving the center propeller.

The launching weight of the "Olympic," about 27,000 tons, was the heaviest weight ever transferred from land to water; and this operation, always a matter of anxiety to those in charge, was naturally, in the case of so huge a vessel, an undertaking of unusual importance. The method of launching was very simple. The vessel was held on the ways by hydraulic triggers, which were released by the mere opening of a valve, in order that the vast structure might glide into the water.

Some idea of the enormity of the "Olympic" may be obtained when we consider the size and quantity of some of the parts that entered into her construction. Her rudder alone weighs 100 tons, and the weight of the castings comprising the stern frame, rudder, and brackets amounts to 280 tons, or 60 tons more than those of any other steamer. They were manufactured at Darlington, and special arrangements had to be made for their conveyance to Hartlepool, whence they were shipped to Belfast. The largest beam weighs four tons and measures 92 feet; the longest steel plates are 36 feet. There are 2,500,000 rivets in the ship. Each engine crank-shaft weighs 118 tons; each bed-plate, 195 tons; each column, 21 tons; and the heaviest cylinder with its liner, 50 tons; the wing propeller, 38 tons. The weight of the casting for the turbine cylinder is 167 tons, and of one of the solid bronze propellers, 22 tons. The anchors are 19 feet in length and over 15 tons in weight, and each link of their chains weighs several hundredweight. Twelve horses were required to drag one of the anchors to the Naval Exposition at Olympia.

The equipment and furnishings of the vessel have likewise driven home the gigantic size of her hull. Besides the usual dining rooms, lounges, saloons, drawing and smoking rooms, restaurants, and verandas and cafés, all beautifully decorated, the "Olympia" will be provided with a complete and well-equipped Turkish bath, a spacious swimming bath, a full-sized squash and racquet court, with a gallery for the use of spectators of the game, electrical bath establishments, sun parlors, sport decks, palm courts, lifts, gymnasiums, etc. These accommodations are provided for 2,500 passengers. The crew will number 860.

Since the
no vessel, e
has created
"Olympic,"
size, but al
naval archit
we publishe
Transatlanti
evolution of
tannia," wh
the Atlantic
day "Olymp
between the
and her spe
her enormou
mum speed
and in pro
The two d
"Britannia"
a vessel w
12.5 knots,
in 1855, w
13.8 knots.
naval mast
time that s
theless a l

The Structure of Metals

By DR. ALFRED GRADENWITZ.

ONE of the most difficult tasks incumbent on the managers of machine shops, is the examination of the mechanical and electrical properties of raw materials and the utilization of the results thus obtained for their continued improvement.

In the electrical industry this task, because of the peculiar conditions of the case, becomes especially complicated. In fact, the mechanical properties (hardness, ductility, mechanical strength, etc.) being anything but parallel to the electrical properties (insulation, conductivity) two opposite tendencies have to be accounted for. This industry therefore is especially interested in availing itself of the most perfect processes of chemical and of mechanical analysis.

Whereas the chemical composition of a given material can always be ascertained by means of a more or less complicated analysis, the thermal processes (melting and annealing) and the mechanical operations (rolling, compression, drawing, etc.) undergone by the material, cannot be checked by the old methods with all the accuracy and safety required. The metallographic methods recently suggested are therefore specially useful in this case.

The Cable Works of the A. E. G. of Berlin has been among the first to adopt this method. The following examples, two of which are illustrated herewith by microphotographs for which we are indebted to the courtesy of the directors of the works, will give a striking idea of the many advantages afforded by a microscopic examination of polished cross-sections.

The first example is a microphotographic picture representing a brand of cast copper as obtained from wire refuse in the refining furnace: The copper (Cu) having absorbed in melting, large amounts of oxygen (O), has united with this element in the shape of red oxide of copper (Cu_2O) incorporated with the copper under the shape of a fine powder, up to a certain density corresponding to saturation. By an examination of the microscopic cross-section, the crystals of pure copper (1) are seen suspended in a saturated solution (2) of copper-red oxide of copper.

In the second example, Fig. 1 represents a micro-

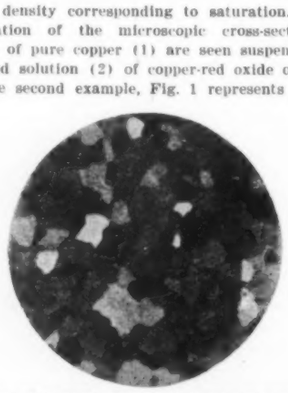


FIG. 1.—A MICROPHOTOGRAPHIC PICTURE OF CAST COPPER SUPERHEATED INTENSELY
Magnified 10 times

FIG. 2.—STRUCTURE OF SAME SPECIMEN WHEN NON-MAGNETIC

photographic picture of cast copper in which the percentage of red oxide has been increased by intense superheating. Wherever the limit of saturation was exceeded, the red oxide has separated from the solution as well-defined crystal. The following three components of the metal structure are therefore observed in the microscope: Pure copper (1), copper-red oxide solution (2), pure red oxide of copper (3).

In Fig. 2 is shown the microphotographic picture of a roughly purified cast copper where the oxygen has been accumulated with a view to burn any metallic and non-metallic impurities as well as to prepare a reduction as violent as possible of the oxygen, forcing any foreign substances burnt or otherwise, to the surface of the bath by a purely mechanical process. As soon as this reduction has been affected the picture (as seen from Fig. 2) only comprises some thin threads of red oxide (2) and copper crystals (1).

Another example, finally represents a perfectly-refined cast copper. As the red oxide, even in slight quantities, is detrimental to the mechanical and electrical properties of copper, the oxygen having once done its duty, should be driven out completely. The cast copper therefore is submitted once more to intense heating and to reduction, after which even the most minute metallographic observation will no longer ascertain any traces of oxide. Reduction is effected by the immersion of a birch trunk, the components of which (carbon and hydrogen) possess so strong an affinity for oxygen that this element, suddenly leaving the copper in great amounts, combines with the reductive elements, while the melt undergoes a violent seething.

Similar sets of metallographic pictures are prepared at the Cable Works of the A. E. G. for any operation of some importance, three chemists being intrusted with the checking of materials by comparing these pictures with those of typical standard.

After having enriched to a surprising extent our

knowledge
promises t
the engine

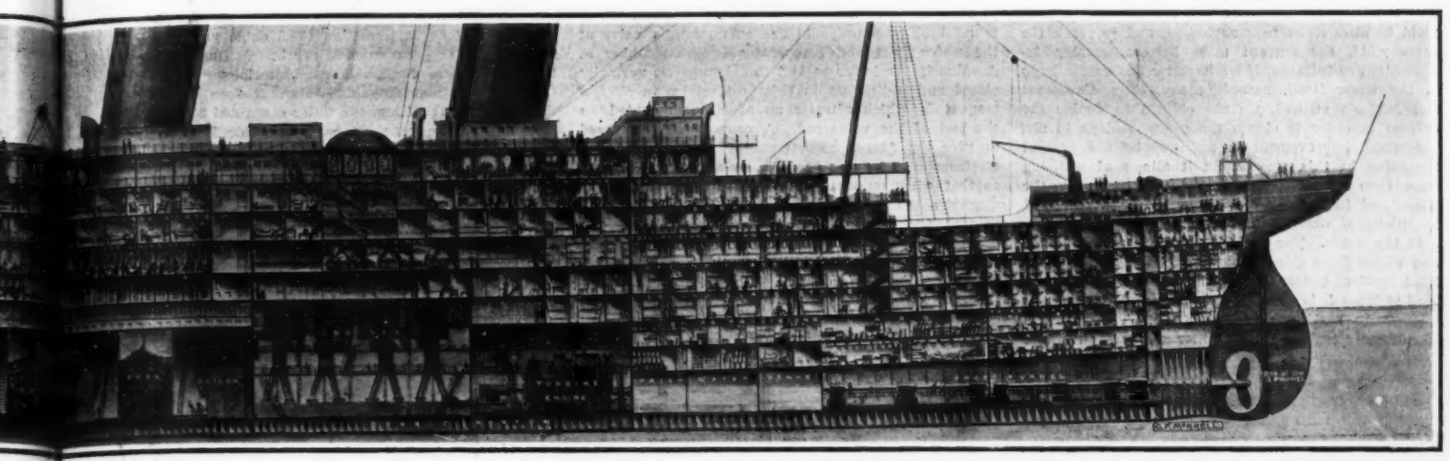
The City

By the

THE fact
large scale
well brough
at Marseill
that the D
bacteria, th
a suitable
which shou
time. The
the ultra-v
sterilizing,
out with
amount of
to describe
which is d
De Recklin
that the e
Paris Univ
There seem
new metho
backs whic
it comes to

In the su
occupy a
properly o
sides, the
is high.
sterilizing
taste to t
favored fo
for munici

The Olympic"—a 60,000-ton Vessel



tonnage being half as much again (32,500 tons) as that of the "Mauretania" or the "Lusitania," which until now have held the record for size. Her dimensions are: Length, nts, contains nine steel decks, and provides accommodation for 2,500 passengers, besides a crew of 860. She is a triple-screw boat and her engines of 45,000 horse-power er interior. The "Titanic," her sister ship, will be launched early this year. Each vessel, when completed, will have cost $7,200,000. From the Graphic.

WORLD'S GREATEST SHIP.

Since the advent of the "Great Eastern" in 1858, no vessel, except the "Mauretania" and "Lusitania," has created such a vast amount of comment as the "Olympic," not only on account of her enormous size, but also because she represents a new type in naval architecture. In our issue of June 19th, 1909, we published an article on the "Development of the Transatlantic Steamship," in which we traced the evolution of the modern liner from the old "Britannia," which was the first vessel that ever crossed the Atlantic on a regular schedule, to the present-day "Olympic." We pointed out, at the time, that between the "Britannia," with her length of 215 feet and her speed of 8.5 knots, and the "Olympic," with her enormous length of nearly 900 feet and her minimum speed of 21 knots, the changes in construction and in propelling machinery have been remarkable. The two decades that followed the advent of the "Britannia" saw the advent of the "Asia" in 1850, a vessel with a length of 275 feet and a speed of 12.5 knots, and the "Persia," an iron steamship built in 1855, with a length of 385 feet and a speed of 13.8 knots. Then came the "Great Eastern," Brunel's naval masterpiece, a ship so far in advance of her time that she proved a commercial failure, but nevertheless a harbinger of the development which has given us the "Olympic." The "Great Eastern" with a length of 692 feet and a displacement of 28,000 tons was not exceeded until the "Oceanic" made her appearance in 1899 with a length of 705 feet, a maximum displacement of 32,500 tons, and a speed of 20.7 knots.

The "Great Eastern" marked the transition from the paddle to the screw; for she was equipped with both. The "China," built in 1862, a ship of 337 feet in length with a speed of 14 knots, was propelled by a single screw only. After that the screw propeller completely displaced the paddle wheel. Up to the time of the "City of Paris" and the "City of New York," practically all of the vessels were driven by single screws, a method of propulsion which reached its highest development in the "Umbria" and "Etruria," 525 feet in length, and 19.6 knots of speed, with engines of 14,500 horse-power. With the "City of Paris" and the "City of New York," began a new period of twin-screw ships driven by triple-expansion engines. When they went into service in 1889, they were by far the finest ships afloat, as well as the largest. They were 560 feet in length, and had a displacement of 16,000 tons.

The "City of Paris" and the "City of New York" were steady and very much along the same lines. The "Lucania," the "Kaiser Wilhelm der Grosse," the "Deutschland," etc., were built in more or less rapid succession, and exceeded their predecessors in size and in speed.

With the building of the "Lusitania" and the "Mauretania," turbine engines permanently entered the field of transatlantic navigation, although the two Cunarders were not by any means the first vessels in which the turbine was installed. In the "Mauretania" and "Lusitania" a speed of from 25 to 26 knots is maintained steadily, but at a cost which might well give less wealthy owners pause. The White Star Line has made no effort to compete with other companies in building ships which will hold transatlantic records for speed. The "Olympic," like her predecessors, the "Celtic," "Oceanic," and "Baltic," is a comfortable ship of moderate speed, as speeds go nowadays. In the combination of reciprocating engines and turbines she represents the entrance of a new type whose performances will be watched with not a little interest.

The launching and other exterior views of the "Olympic" were illustrated in the SCIENTIFIC AMERICAN, November 12th, 1910. The present picture is taken from the *London Graphic* and it gives a sectional representation of her interior.

knowledge of living organisms, the microscope thus promises to render an equally efficient assistance to the engineer engaged in industrial pursuits.

The City Water Sterilizing Process Used at Marseilles

By the Paris Correspondent of the SCIENTIFIC AMERICAN.

THE fact that city water can be sterilized on a large scale by the use of ultra-violet rays has been well brought out in a series of tests which were made at Marseilles not long since. Owing to the knowledge that the Durance River contains a large amount of bacteria, the municipality felt the need of providing a suitable method for sterilizing the water and one which should allow of a large delivery at the same time. The results of the tests seem to show that the ultra-violet-ray method is by far the best for sterilizing, and is at the same time easy to carry out with a rapid delivery and takes but a small amount of current, hence the cost is low. We wish to describe the new apparatus for city water use which is designed by Messrs. Henri, Helbronner, and De Recklinghausen, and it is gratifying to observe that the experiments carried out by V. Henri at the Paris University are now taking a practical shape. There seems to be a great future in store for the new method, seeing that it has none of the drawbacks which are found with the other processes when it comes to using it on a large scale.

In the sand-filtering method, for instance, the filters occupy a large surface of the plant, and when not properly operated the results are very imperfect. Besides, the first cost of installing the filtering plant is high. Chemical products added to the water for sterilizing have the disadvantage of giving a bad taste to the water, and the method is not much favored for that reason. One of the best methods for municipal plants has been the ozone process, and

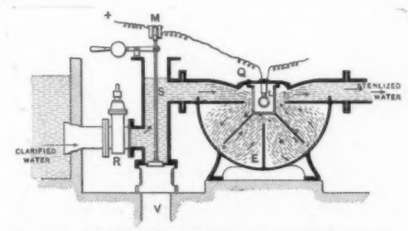


FIG. 2.—SECTIONAL VIEW OF APPARATUS FOR STERILIZING CITY WATER

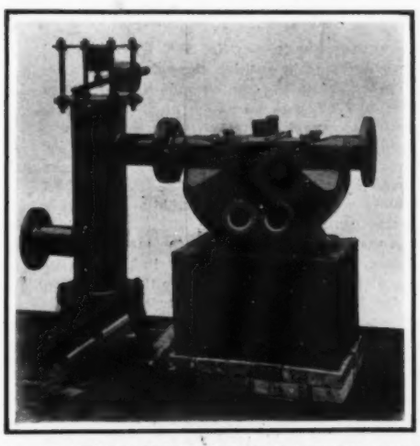


FIG. 1.—APPARATUS USED FOR STERILIZING CITY WATER BY EMPLOYING ULTRA-VIOLET RAYS

it has been used in some large cities. However, it gives a certain taste to the water which disappears but slowly, and on the other hand there must be great care taken in the ozone production in order to avoid forming any nitrogenous products, which would vitiate the water. Hence the process is somewhat difficult to carry out, or at least needs great care and attention.

In order to find the best solution of the problem, the municipal council of Marseilles organized a concourse of sterilizing apparatus. Such a plant was required to deliver 200 cubic meters (261.5 cubic yards) of water per 24 hours, and was to be run continuously for one month. The inspection committee included some of the leading specialists in hygiene, mining and civil engineers, and professors of universities. The results of the tests showed that the ultra-violet-ray process was undoubtedly the best for municipal use, as it has none of the defects which we mentioned above. It uses a small amount of current, and this has now been lowered in the new apparatus. Neither taste nor smell is given to the water, and the sterilizing is very effective. At the same time the process is easy to carry out and the apparatus needs but little attention. The first cost of the plant is low, and it occupies but a small space.

The ultra-violet-ray apparatus was used in connection with a Puech-Chabal filter in order to act upon clear water, and this was necessary from the fact that the Duvance water is very heavily charged with impurities which render it turbid. After leaving the filter it passes at a continuous rate through the ultra-violet-ray apparatus.

Fig. 1 of our engravings shows the appearance of the Marseilles apparatus and Fig. 2 the sectional view. In the former apparatus, the lamps were placed above the surface of the water upon floats, so that all of the radiation from the lamp could not be used, and in fact there was only one-third of the rays actually employed for the sterilizing. The authors sought for a means of utilizing a greater proportion

of the rays without changing the manner of working the arc. It is recognized that the working of the lamp depends essentially upon the temperature of the electrodes and the luminous tube, so that if we cool the lamp too much we will not obtain the same yield in ultra-violet rays as before, and to reach the same yield, the current must be considerably increased. For instance, if we immerse the quartz lamp in the water itself, according to Messrs. Courmont and Nogier's method, we are obliged to double the current in order to obtain the same yield as in air.

A great improvement is obtained by the present apparatus in this respect, as it allows of utilizing more than three-quarters of the rays given by the lamp, and here the lamp burns in air at its best conditions of working and we thus avoid immersing it in the water. The lamp is placed in a rectangular case whose three sides lying parallel to the lamp tube are formed of quartz plate. The tight box *Q* containing the lamp *L* is placed in a semi-circular apparatus having five partitions in the inside. The water is taken from a tank of filtered water and passes through a gate valve and a cylinder chamber *S*, then entering the main tank *E*. It follows around the path which the arrows indicate, and in this way it is exposed for some time to the action of the ultra-violet rays, so that we have a powerful sterilizing effect. It is found best in practice to use an automatic valve at the water inlet and it operates in the chamber *S*. A valve in the lower part of the chamber is normally closed and is held up in this position by an electromagnet *M* which attracts an armature mounted on the end of the valve rod. A counterweight is used to give the proper adjustment of the weight. The electromagnet is connected in series with the lamp, so that when current passes in the lamp circuit the magnet acts and the valve is held closed. Should the current fail or the lamp break, the magnet allows the valve to drop, and the water now passes directly out of the apparatus by *V* into the sewer or elsewhere and no water will be delivered into the sterilizing chamber. Thus there is no danger of having unsterilized water flowing through the apparatus in case the current should fail. During the tests which were made at Marseilles, the authors used a quartz lamp of the Westinghouse-Cooper Hewitt type, with a current of 22 volts and 3 amperes, and the apparatus was run from August 19th until the end of September, working day and night without stopping. It gave an output of 60 cubic meters (78.5 cubic yards) per 24 hours, or 32¾ cubic yards per hour. During that time there were made eighteen bacteriologic tests of the incoming and outgoing water. Before entering the apparatus the (impure) water contained 30 to 300 germs per cubic centimeter (0.061 cubic inch) and 50 to 1,000 coli bacillus per liter (1.057 quarts). After sterilizing, we have on the average one germ per cubic centimeter and no coli bacillus in any case. The tests show therefore a run of six weeks, which gives a continuous sterilization of filtered water with a mean output of 25 cubic meters (32 cubic yards) per hour, using current at the rate of 660 watt-hours. This gives the lowest value which has yet been obtained, or 26 watt-hours per cubic meter of water (20 watt-hours per cubic yard), so that we have a striking progress with the new apparatus.

Drifting of the Sun's Family

A Great Unsolved Astronomical Problem

By Arthur H. Bartlett

THE part of the heavens, toward which it is believed the Sun with its entire family of planets, comets, satellites and meteor-streams, including, of course, our own Earth, is moving with great velocity, is situated at this season directly overhead about 6 o'clock in the evening, and at a later hour a little farther toward the northwest. This is one of the most interesting and important localities in the firmament to astronomers, toward which their attention and observation have been directed for many years past.

The greatest fact which modern astronomy has revealed is that our whole solar system is now journeying toward the constellation Lyra in the northern heavens, and the greatest of the unsolved problems of astronomy is when, where, and how this journey began, and when, where, and how it will end. This journey is unceasing and unchanging, and is believed to be at the rate of twelve miles per second, or about 300,000,000 miles in a year. The question as to whence we came and whither we are drifting is one of vast importance, and is still engaging the attention, as it has in the past, of the leading astronomers of the world, for in connection with it is involved the even greater question regarding the structure, extent and boundary of the universe.

If we look up to the sky, directly overhead, just after sunset, we shall see a star of the first magnitude known as Vega, which is located in the constellation Lyra, the Harp, and is plainly visible throughout most of the evening. This star, next to Capella, is the brightest north of the equator, and is famous as being the one which, in 12,000 years, will occupy the important position of the "Pole-star," and will be known by that name in the future. The star shines with a bluish-white light, and may be easily recognized, as it is the most conspicuous of any star visible near the zenith at this season.

It is toward this star, or rather the group to which it belongs, that our Earth and the solar system are believed to be moving, and this point in the heavens is known to astronomers as the "apex of the Sun's way." During the last 120 years many astronomers, with ever increasing accuracy, have sought to determine the point toward which our Sun, the Earth and all the other planets are moving. For many years the result of investigations was that our system is traveling toward the constellation Hercules in the northern sky. But more recent and careful measures lead to the conclusion that the point is located in the nearby constellation Lyra. This point is nearly four degrees south and slightly east of the bright star Vega, the variations between final measurements, maxima and minima, of all who have attacked the great and highly complex problem being as much as seven degrees.

Owing to the "solar drift" in space, the orbit of our Earth, instead of being an ellipse, is really of a corkscrew shape, the axis of the "corkscrew" being in the direction of the constellation Lyra. The great star-cluster in Hercules, containing over 6,000 visible suns, is not very far away from that part of the sky which we are approaching, and it is possible that our system may form a distant part of one of its encircling wisps of star-strewn nebulous matter, so that in this case we may eventually be drawn into the gigantic cluster.

Most astronomers agree as to the general direction of the Sun's motion, but owing to the motion of the stars themselves, there is not yet an exact agreement regarding the amount or direction of this motion. In a general way we may say that if an observer looks up to the heavens a little southwest of the zenith, on a clear evening at this season, he may correctly imagine our Earth and the great system to which it belongs as moving toward the star he there sees presented to his view. This motion has been going on since the creation, and will probably continue for unknown ages in the future.

It is true, as a recent writer has well remarked, "That since the 'beginning' we, with the Sun, have been steadily speeding on and on through interstellar space without once meeting or passing a single lonely stars, brings home to our realization as no other consideration can, the amazing amplitude of cosmic space, the completeness of the isolation of each star from all others, and the supreme magnificence of the scale of the stellar universe."

Quite recently a new and ingenious theory has been advanced by two astronomers who have attempted to prove that the millions of stars composing our immense universe are moving in two parallel streams, traveling in contrary directions, and situated in opposite regions of the heavens, but their novel ideas have not been confirmed and have received little attention from astronomers who regard them at present as nothing more than an interesting speculation which does not admit of a practical demonstration, though it is possible that careful and long-continued observations in the future may produce evidence in its favor.

The direction of our motion is indicated by the fact that the stars in that part of the heavens toward which we are traveling are observed to spread out and get farther apart, while those we are leaving in the opposite part of the heavens close up and gradually approach each other, just as in walking through a forest the trees in front of us are seen to open out, while those in the rear appear nearer together as we leave them behind. But at present it is not known whether we are moving in a straight or curved path, and if in the latter it is so great that it cannot be determined. Many stars which have a "proper motion," as it is called, appear to be moving in a perfectly straight path through the sky. Among them is the faint star known as "No. 1830 Groombridge," which is believed to be rushing through space at the rate of over 200 miles per second—a velocity so great that the combined attraction of all the masses in the universe cannot stop this star in its swift and solitary flight over the firmament. It is known to astronomers as the "Runaway Star," but there are some other stars that are believed to be traveling even more rapidly, and none of them exhibits any indications of moving in a curved path.

It is interesting to remark that the motion of the solar system plays an important part in the shifting panorama of the heavens. Not only do the stars move onward, but the Sun, moving also, carries us continually northward, so that our point of view is ceaselessly changing, and looking out from the flying Earth, we are like people on a ship which is passing by a squadron of other ships. Their evolutions cause them to appear in constantly changing relations to one another, and at the same time our own motion, shifting the line of sight, produces other changes of view, which increase the complexity of the apparent movements. In short, we are reminded of the remarkable resemblance of the universe to the modern conception of an atom, in which the restless corpuscles are speeding in all directions, so that an infinitesimal being, inhabiting one of those corpuscles, would see the other corpuscles shaping themselves into constellations that would be as unenduring as are the figures that the poetic imagination traces among the stars.

The famous German astronomer Mädler, over fifty years ago advanced the theory that our Sun and all the stars—which are also Suns—are moving in a great orbit around the star Alcyone located in the Pleiades, a prominent cluster mentioned in the Bible, and known as the "Seven Sisters," six of which are plainly visible to the naked eye and may be seen at this season just above the eastern horizon about 8 o'clock in the evening. But Mädler adduced no evidence in support of his views, which were not generally accepted by astronomers. His ingenious theory was exploded many years ago, and astronomers do not at present recognize any particular star as the center around which all the other stars revolve, though it is possible that such a center exists somewhere in the universe.

The theory that the solar system is revolving around a central Sun was first suggested by Thomas Wright, of England, in 1750, and later Mädler supposed that he had discovered the exact center of this motion; but it is not thought by astronomers that sufficient evidence exists to support this belief, and all that can be said to be established at present is, that the Sun with its great family of revolving worlds, is rushing through space toward a point in the constellation Lyra, a familiar group of stars located in the northern heavens, and which may be seen to good advantage at this season in the early evening.—*Popular Astronomy.*

Albinism and Heredity

DR. AND MRS. CHARLES B. DAVENPORT, of the Laboratory for Experimental Evolution maintained by the Carnegie Institute at Cold Springs Harbor, Long Island, have recently published another installment of their studies on human pedigrees from the point of view of heredity. This is concerned with the question of albinism in man, and some of the conclusions are of general interest.

So far as the evidence goes, the children of albinos are always albinos. In albino marriages albino children may be expected without regard to the parentage of the albinos themselves. For example, in one of the cases given, the mother was of negro parentage, while the father was of Caucasian parentage; but the offspring was without any pigmentation.

The authors think that in every new case of albinism there is a probability of consanguinity among the parents. But this seems to be reasoning backward from the fact that out of a number of cases one-third of all the albinos arose from consanguineous marriages. The facts appear to agree with the general rule that a recessive character (and albinism is a recessive character in most animals that have been studied) arises only when both parents carry the same defect; "and the probability that both carry the same defect is increased when both belong to the same strain."

The proportion of albino offspring in any family accords with the Mendelian expectation, in the long run, as in other mammals. When one parent is albinic

and albinic offspring occur at all, there will be one-half albinic and one-half pigmented; in these records there were sixteen albinic and fifteen normal children in five families.

Comparison of the hair coloration in the parentage of albinos with that in the normal population shows a great preponderance of red and auburn hair among the former, while dark browns and blacks occur less frequently—65 per cent as compared with 81.5 per cent in the general population. Albinos frequently have a blue iris; this fact does not appear to be correlated with the preponderance of blue eyes in the parentage of albinos.

As to the causes of albinism, the authors conclude that it results from the fortuitous union of two germ cells lacking a pigment factor. The meaning of this is not very clear. It may mean either that the parents bear such germ cells as part of their inheritance—in which case it is but another way of saying that albinism is congenital and is inherited according to definite mathematically calculable probabilities, or it may mean that germ cells lacking the pigment factor are present in all individuals in small numbers, and their union is a relatively rare event. The facts brought out in the study point to the first as being the probable meaning of the authors; but in that case we are still in the dark as to the cause of albinism.

Paris as a Seaport

A Proposed Canal between Paris and Rouen

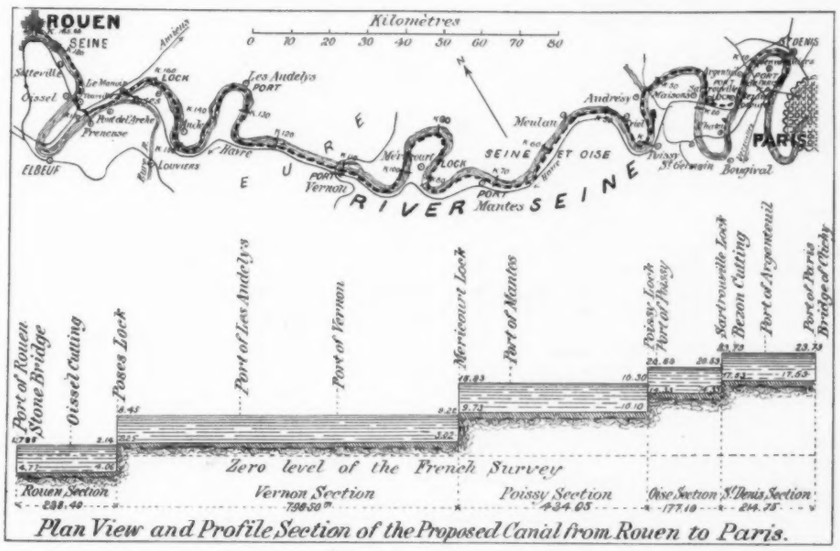
By the Paris Correspondent of the Scientific American

A PROJECT has recently been made to establish a navigable connection between Paris and the English Channel, so as to convert the French capital into a seaport and allow vessels up to 3,000 tons draft to unload freight at the docks. The cost of this undertaking is estimated at thirty to fifty million dollars. Aside from the other obvious advantages which would be derived from such a plan, one circumstance which commends it particularly is the fact that it would preclude all possibility of any repetition in the future of such disasters as were recently caused by the flooding of the Seine. The idea of turning Paris into a seaport is not by any means new, but has of late years been suggested repeatedly. One of its principal advocates was M. Bouquet de la Grye, who in 1886 presented a project to the government, suggesting a deepening of the bed of the Seine between Paris and Rouen. From this point on to the mouth of the Seine at the English Channel (a distance of 76 miles) the natural depth of the river is sufficient, and at the present time vessels travel up the Seine as far as Rouen, where the minimum depth is 16 to 18 feet, the port accommodating vessels ranging up to 3,000 tons. From Rouen to Paris the Seine channel has a depth of only 10 feet. It is proposed to increase this to 21 feet so as to enable vessels to travel all the way to Paris by water. The channel would follow all the windings of the Seine except for two short cuts where a separate canal would be built so as to avoid crossing the Paris-Havre Railroad. Our illustration, for which we are indebted to *L'Illustration*, shows this and other features to be referred to below. The total distance of the journey is about 130 miles and would be covered in about eighteen hours with the usual tugboats. As regards the width of the river, it is 115 feet at water level in straight portions, and 150 feet at curves with a radius of less than 5,000 feet. By the way of comparison it may be mentioned that the Manchester canal has a maximum width of 119 feet, while the Suez canal is 122 feet broad. The project in its present form provides for five levels with locks, while the section from Rouen to the Channel would be open and would take up the variations of the tide.

The plans include twenty-four drawbridges. The port at Paris would be located at the suburbs of St. Ouen. The total cost of the engineering work is estimated at thirty million dollars and the total capital invested at fifty millions.

This project of establishing a seaport at Paris has now once more come to the foreground and is being discussed in the daily newspapers, in Parliamentary circles, and also by the municipal council of Paris, who are in favor of its adoption. Just at this time, with the memory of the Seine inundation freshly in people's minds, and with the pressing problem of providing measures to guard against such accidents in the future, the soil is very favorable for the project to strike root. It would save the community the dead cost which would be involved in carrying out any of the other plans that have been proposed for coping with the situation. The cost of the project outlined above might quite probably be borne by a private enterprise. The municipal council is now, however, disposed to have the city take the matter into their own hands and has pronounced its sentiment to this effect by a unanimous vote. That the city is quite capable of handling such enterprises successfully is evidenced by the very extensive network of the Paris subway, which when completed will have an aggregate length of no less than seventy miles. In any case the enterprise would pay for itself. A tax of $0.40 to $0.60 per ton gage for sea-going vessels would be collected, and also pilot taxes and other rates for river boats, thus yielding a constant return. Soon after the enterprise was placed on a working basis, the receipts would, no doubt, pay 5 per cent interest on the capital and yield a handsome surplus. This is a very conservative estimate and takes no account of the great increase in traffic which would no doubt develop in the future. It is estimated that having regard only to traffic which can be counted on with practical certainty, this would amount in the second year of operation, to about ten million tons.

The project is attracting attention in countries outside of France, especially those which now possess large seaports such as Antwerp and Hamburg, and should it be carried out, Paris will enter into competition with these ports as well as with London, so that the entire European traffic will be affected. Antwerp would lose a part of its shipping, which now comes from Paris and Eastern France, Alsace, Switzerland, and Bavaria. It is interesting to note



Plan View and Profile Section of the Proposed Canal from Rouen to Paris.

that towards the end of the century recently completed, London lost something of its supremacy as a European freight seaport. Gradually we have seen Germany, Belgium, and Holland assuming an independent position of prominence. Since 1893 the traffic of Hamburg has increased 80 per cent; Antwerp has about the same showing, and Rotterdam has gone up by no less than 160 per cent. During this period the London traffic increased by only 30 per cent. France, however, has been far behind as regards the merchant marine, and could not compete with other leading countries. At the present time France sends on an average twenty-five million dollars' worth of freight to London to have it re-shipped from there to different points of the globe. Should the new project be carried out, this state of affairs will be entirely changed, and Paris will rank among the principal seaports of Europe. It will receive within its harbor vessels arriving from distant countries. A boat which has traveled some ten or thirteen thousand miles coming from Australia, South America, or China will not hesitate to go a little extra distance and land at Paris instead of London, if the conditions of the trade render it desirable.

The Independence Bell of Mexico

IN connection with the recent centennial celebration of the independence of Mexico, it may not be so generally known that each year, on the recurrence of the anniversary, which is always joyfully celebrated, an interesting scene is to be witnessed in the Mexican capital. On the evening of this day, President Diaz, with his ministers and state officials, assemble in the great ambassadors' hall in the palace. In the great Zocalo, before the National Palace, is waiting a crowd of many thousands, high and low, poor and rich. In the "Biography of Porfirio Diaz," compiled by Tweedle, the scene, as witnessed annually, is thus described: "It is historic ground on which the crowded masses stand, for here, many, many years ago, arose the great Aztec temple. Under their feet, deeply buried, lie altars and urns, sacrificial stones and axioms, and many heads of the great snake—much has already been brought to light, but the earth still covers and envelops a great deal.

"And now a new race celebrates on this sacred ground, the memorial day of their regained liberty. The national palace is gaily decorated and the city hall opposite is brilliant in bright illumination; in the dark, wonderfully beautiful sky the moon shines silvery with a soft radiance, surrounded by innumerable glittering stars. Below, however, the bright electric lights gleam on the white shirts and the red hats of the men and the multi-colored rebozos of the women; all gaze earnestly at the great, brightly lighted clock, the hands of which approach the hour of eleven. But a minute of the time is lacking when the balcony doors of the palace are thrown wide open, and from the apartment within, the President makes his appearance, clad in festal garb, with the broad sash of the President's office across his breast, and in one hand the flag of Mexico. Behind him are ranged the ministers. In the pent-up silence of the waiting throng, he raises his hand to the cord leading up to the great bell hanging above him and rings on it eleven strokes. Deep and full, the resounding notes of the great bell tell of the nation's independence as it did, on a previous occasion, one hundred years ago, when it rang from the Dolores church. It was brought from there to Mexico in 1896. When the last stroke has resounded, the President proclaims in ringing, far-reaching tones, 'Live the independence and live Mexico.' The silence is broken, the solemn moment is passed and a many thousand-throated cheer rings over the great plaza in the stillness of the night."

The fact has been established that the bubonic plague is primarily a rat disease and that it is transmitted to human beings chiefly by means of fleas which infest rats. Permanent freedom from the rat pest can be secured only by preventive measures. The means of ingress to a building must be stopped and the animals deprived of food, when they can be easily trapped. The bacteria preparations on the market for killing rats may be depended on to kill the rats which eat the prepared bait, but they do not set up an epidemic, as has often been claimed. They are inferior to the poisons and their price is practically prohibitive when used on a large scale.

The Destruction of Weeds by Chemical Means—I*

An Important Agricultural Problem

By Harold C. Long, B.Sc., Author of "Common Weeds of the Farm and Garden"

DURING the past twenty years an increasing amount of attention has been devoted to the economic side of insect and fungous pests, with a view to their extermination, and The Destructive Insects and Pests Act of 1907 gives the Board of Agriculture and Fisheries power to deal with the whole question, and to carry out compulsory preventive and remedial measures in the case of such species as they consider of sufficient importance to schedule in their orders.[1] The attention of scientific workers has for many years been turned to the necessity of acquiring a thorough knowledge of the life histories of all the worst insect and fungous pests of farm, garden, and orchard, and a vast fund of information has been acquired by a systematic study of individual species. Such study, in conjunction with experimental work, has been necessary in order to eradicate the particular pest concerned, and here also much has been accomplished, even though it be said that much remains to be done.

FIG. 1.—Charlock (*Sinapis arvensis* L.) × 2/3. This Weed is Readily Destroyed by Spraying with a Solution of Copper Sulphate or Iron Sulphate.

What, however, is the position in regard to the prevention and eradication of the common weeds of the farm and the garden which annually cause so much loss to the grower of crops? It may be said that a good deal has been done to enable the unbotanical worker to identify species, and a few practical botanists and agriculturists have offered sound advice as to the mechanical destruction of weeds. Yet the information available is still quite inadequate, and while some of the highly farmed lands are more or less weedless, the majority of farmers meet with two or three species of weeds which they experience extreme difficulty in combating. The question of weed eradication is one of real difficulty, and when we bear in mind the fact that many serious insect and fungous pests are supported and distributed by weeds, it assumes an importance which the entomologist and mycologist would do well to recollect. Prof. Somerville has written:[2] "Using the term in its widest sense *good cultivation* will be found to be the best protection that the farmer or gardener can offer his crops against insects," and good cultivation includes the destruction of weeds. In many countries the importance of destroying weeds has long been officially recognized, and acts have been passed requiring the destruction of specified weeds. In Great Britain, however, the only laws of the kind refer to Ireland and the Isle of Man.

FIG. 2.—Persicaria or Redshawk (*Polygonum Persicaria* L.) × ½. This is a Pest of Good Arable Land and Gardens. It Has Been Quite Destroyed by a 4 Per Cent Solution of Copper Sulphate (100 Gallons Per Acre).

THE PREVALENCE OF WEEDS.

We have said that some highly farmed lands are more or less weedless, but it is undoubtedly true that most farms are far more weedy than they either ought to be or need be. In the third week of August, 1909, we found in an area of perhaps a hundred square yards of a wheat field no less than twenty-nine species of weeds, the majority of which were among the most troublesome of all (including the species illustrated in Figs. 1, 5, 6, and 8). Similar cases could be quoted. We consulted twenty-nine experts in different parts of the country, from the North of Scotland to the South of England, and species of "couch or twitch" were included thirty-two times among the six worst weeds of arable land, charlock and runch twenty-eight times, docks sixteen times, thistles sixteen times, coltsfoot thirteen times, and so on. As regards grass land, thistles were regarded as the worst in twenty-two cases, buttercups sixteen, Yorkshire fog (*Holcus lanatus* and *H. mollis*) nine, docks eight, and so forth. These figures show that the species named are not only widely distributed, but in the cases mentioned are real pests of farmers. In good garden soil, well cultivated for three years, we found one thousand and fifty seedlings in a square yard on May 17th, 1909, and of these seedlings six hundred and fifty-four were those of creeping buttercup, one hundred and seven *Poa annua*, and sixty were a species of dock. Many seedlings were subsequently destroyed on the same square yard. Plenty of other evidence as to the prevalence of weeds could be adduced.

FIG. 3.—Petty Spurge (*Euphorbia Peplus*), Natural Size. This Weed is Very Common and Plentiful in Some Districts. It Appears to be Protected From Spray Fluids by a Glaucous Bloom on the Leaves.

THE HARM DONE BY WEEDS.

Many pages could be written dealing with the losses caused by weeds, but the matter can only be briefly mentioned here. It may be stated, however, that weeds take up the space which should be occupied by the cultivated plant; weeds rob the crop of food and moisture, and of air, light, and heat; they hinder thorough cultivation, harbor injurious insects and fungi, are parasitic on crops, may be poisonous, stop up drains, and their seeds may very seriously reduce the value of those of agricultural plants, which hence require very thorough cleaning, involving considerable expense. In short, the cash losses due to weeds are very serious. The following examples will suffice:

(1) The nitrogen in the dry matter of Persicaria (*Polygonum Persicaria*) was found to equal nearly 20 per cent of albuminoids.[3]

(2) A twenty-five bushel crop of wheat was found at the Agricultural Experiment Station of Cornell University to transpire (during growth) five hundred tons of water. Weeds probably transpire to a somewhat similar extent.

FIG. 4.—Corn Cockle (*Agrostemma Githago* L.) × 2/3. Not Only a Weed in the Usual Sense, but it is Poisonous in a Degree. Spraying is Partly Effective and Generally Prevents Seeding (See Text).

(3) Charlock (*Sinapis arvensis* L.) and other crucifers are hosts for the Turnip Flea Beetle or "Fly" (*Phyllotreta nemorum*), the Turnip Gall Weevil, (*Ceutorhynchus sulcicollis*), the Diamond-Back Moth (*Plutella maculipennis*), Finger-and-toe Turnips (*Plasmodiophora brassicæ* Wor.), *Peronospora parasitica* De Bary, and other pests.

(4) Wollny has placed the annual loss of crops due to weeds in Bavaria at an average of 30 per cent.[4] Korsmo found the percentage loss in money value on a weedy compared with a clean plot of barley to be 46 per cent, and in the case of potatoes 49 per cent.[5] Experimental plots at University College Farm, Reading, showed that with two hoeings only after "singling" mangolds yielded over thirty-seven tons per acre, but when unweeded the yield was only slightly over sixteen tons per acre.

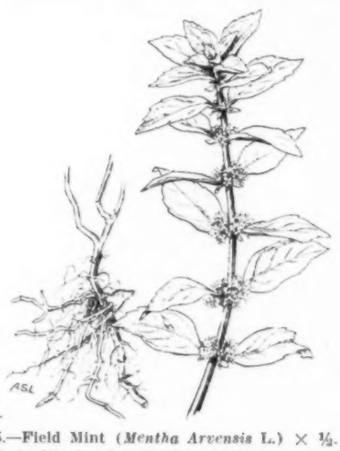


FIG. 5.—Field Mint (*Mentha Arvensis* L.) × ½. Pest of Arable Land, and Most Difficult to Eradicate Owing to the Creeping Root-Stocks.

(5) If the real value of agricultural seeds, owing to impurity and low germinating power, be only 76 per cent., then the (initial) loss in cash would be 24s. ($5.82) in £5 ($24.25) if bought at the rate for best seed.

THE DISTRIBUTION OF WEEDS.

Regarding the manner in which weeds are distrib-

* *Knowledge.*

[1] The Destructive Insects and Pests Order of 1910, schedules sixteen "destructive insects and pests," whose presence on any premises must be notified to the Local Authority or to the Board of Agriculture and Fisheries.

[2] Farm and Garden Insects, p. 30.

[3] Stutzer and Seidler, *Fühling's Landw. Zeitung*, June 15th, 1908, p. 429.

[4] Fr. Maier-Bode, *Die Bekampfung der Acker-Unkrauter.*

[5] *Tidsskr. Nordske Landbr.* 10 (1903).

weed, it may be said shortly that the seeds are scattered in the same general way as with other wild plants—by transportation through the agency of man, railways, shipping, and so on; by rivers and floods, by birds and wild animals, by wind (owing to extreme lightness of the seeds or to their bearing flight organs), and by seeds adhering to animals (or man) by means of hooks, and so forth. In other cases broken portions of the rootstock may be transported and give rise to new centers of infestation.

CO-OPERATIVE DESTRUCTION OF WEEDS.

We may now consider the means at the disposal of the farmer for the purpose of destroying weeds, and all may be covered by co-operation, which should be devoted to: (1) The supply of pure seeds, free from the seeds of weeds; (2) the mechanical destruction of individual species which may prevail in a given district, by means of the ordinary routine methods practised on the farm, as well as by special measures; and (3) the destruction of weeds by spraying.

If farms are to be kept free from weeds, and farmers are to be prevented from causing infestation of a neighbor's farm by neglect of their own, it must be by compulsory eradication or by co-operation—*farmers must work together.*

Regarding (1) it is clear that a combination among say fifty farmers in a district will enable them to purchase large lots of high-class seeds at a fair price, under guarantee, and to have them sampled and tested. A pure seed supply will thus be insured.

In relation to (2) it may be suggested that mechanical destruction should include co-operative eradication of docks and thistles by the use of docking irons, spuds, thistle cutters; regular cutting of many weeds by hand and by power machines; cutting of weeds on

FIG. 6.—Knot-Weed (*Polygonum Aviculare* L.) Reduced. A Serious Trouble to Farmers. Often Occurs in Incredible Quantities on Light Sandy Soils.

waste lands and roadsides to prevent the formation and distribution of seed; the collection of seed shed at harvest time by the use of box attachments to reapers and binders; thorough cleansing of thrashing machines before they go to the next farm; co-operative purchase and use of surface weeders like the poppy killer, American weeder; and so forth. A year or so ago Dr. Ewart, government botanist of Victoria, suggested[6] that school children should be offered prizes for collecting certain weeds. A police magistrate offered prizes, and 12,000 plants of Ragwort (*Senecio Jacoboea*) were brought in during the first four days, the number quickly rising to 20,000 plants.

(3) The destruction of weeds by spraying is of most interest, and is dealt with below.

THE DESTRUCTION OF WEEDS BY SPRAYING.

It is only in recent years that attempts have been systematically made to destroy weeds by means of chemical substances, these having been chiefly applied in the form of simple solutions. The method appears to have originated in France, where M. Bonnet found,[7] about 1896, that a solution of copper sulphate destroyed charlock (*Sinapis arvensis* L.) without permanently injuring the cereal crop among which it grew.[8] Attention was directed to this fact in the press, and a host of experimental trials was soon conducted, the result being that the facts were quickly established, and in 1900 a leaflet on the destruction of charlock by means of spraying with the sulphates of iron and copper was issued by the Board of Agriculture. Forty gallons of a 4 per cent solution of copper sulphate, or a 15 per cent solution of iron sulphate, may be sprayed over an acre of the crop when the charlock is about three inches high, and if the operation be properly performed during suitable weather, the weed will be destroyed and the cereal remain practically uninjured.

FIG. 7.—Spurrey (*Spergula Arvensis* L.) × 2/3. This Plant is One of the Most Troublesome Weeds on Light Sandy Soils. Being an Annual it is Only Necessary to Prevent the Ripening of Seed. It Has Been Found That a 5 Per Cent Solution of Copper Sulphate Destroys It.

It is believed that the rough, broad, more or less horizontal leaves of charlock catch and retain the solution, while the narrow, smooth, practically vertical leaves of the cereal throw it off, and hence are not damaged. In this connection there is room for further investigation, and it may be commended to the chemist and botanist alike as a source of interesting research.

Since the introduction of spraying for the destruction of charlock, a number of experiments has been carried out, and many investigators have made trials with a variety of plant poisons, the effects of which have been observed when applied to a number of species of plants. Though the results are interesting and some information has been obtained, they are by no means conclusive, but it will be useful to refer here to some of the experiments and their results.

In the course of experimental work in spraying charlock (Fig. 1) with iron sulphate, in 1898, it was found by Prof. Somerville[9] that both at the Northumberland County Farm, Cockle Park, and in the grounds of the Durham College of Science (Newcastle-on-Tyne), all rough-leaved plants, such as thistles, and, to a lesser extent, coltsfoot (*Tussilago Farfara* L.), were crippled; while glaucous plants, like species of *Chenopodium*, were not affected.

It is well known that broad-leaved plants are often scorched when nitrate of soda is broadcasted on them. It was stated ten years ago that a solution of 15 to 40 per cent of nitrate of soda and sulphate of ammonia sprayed on young charlock plants in the early "rough leaf" stage caused them to begin to wither in a couple of hours. Chloride of potassium is said to have a similar effect on charlock when applied in solution.

FIG. 8.—Black Bindweed. (*Polygonum Convolvulus* L.) × 2/3. A Most Mischievous Annual, the Twining Branches of Which May be Several Feet Long and Drag Down Cereal and Other Crops. Partly Destroyed by Spraying With Copper and Iron Sulphate, Seeding Being Largely Prevented.

[9] *The Field*, July 9th, 1898.

About seven years ago Mr. G. F. Strawson stated[10] in regard to copper sulphate that: "It is now admitted that mangolds, as well as beans, peas, tares, wheat, oats, and barley can be sprayed without injury, and the charlock among them destroyed, and that the spraying does no harm to the young grass seeds, clover, sainfoin, and so on, growing in the crop." Evidence on this point, however, is conflicting, as we shall see, and in Germany, V. Rümker, only last year, held that spraying sugar beets with sulphate of iron is hazardous.[11] (There may be some difference in sensitiveness between mangolds and sugar beets, and also in the methods of spraying.) Only this summer Mr. Strawson repeats that mangolds have been constantly sprayed during the last seven or eight years, and that he has never heard of a single instance where the crop was appreciably injured. He also repeats that corn, tares, sainfoin, clover, beans (and peas in most cases), can be safely sprayed with pure copper sulphate to eradicate charlock.[12] The statement regarding mangolds was confirmed a week later in the same journal by another writer.

A good deal of experimental work in spraying has been conducted at the North Dakota Agricultural Experiment Station by Mr. H. L. Bolley, and some of his results are interesting.[13] His experiments commenced in 1896 with copper sulphate and mercuric bichloride, and the results in killing charlock without injury to wheat are described as surprisingly successful. Bolley found that the best time to spray is when the crop and weeds are making rapid growth, that slow-growing weeds are hard to kill, and that the more succulent the weeds the more easily are they destroyed. Sodium arsenite in preliminary experiments was usually much more efficient as a weed destroyer than the sulphates of iron and copper; it acts quickly, destroying the weeds (apparently charlock and "king-head"), even though rain follows within a few hours. Referring to the two sulphates Bolley concludes (in Press Bulletin No. 27, 1907): "These substances are recommended here for mustard and king-head, and will dispose of other annual weeds which they thoroughly wet, including Red River weed, common rag weed, and pepper grass, and will much weaken and retard the development of the French weed, wild buckwheat, black bindweed, rose bushes, wild docks, Canada thistle and many other of the destructive weeds which invade cereal crops." In Bulletin No. 80 (1908) Bolley shows that at the North Dakota Station they have successfully used, in various sorts of weed eradication work, common salt, sulphate of iron, sulphate of copper, corrosive sublimate, and sodium arsenite, but because of its cost and its extremely poisonous character the corrosive sublimate (mercuric bichloride) is not recommended for weed killing, while the arsenite must be used with great caution.

FIG. 9.—Yorkshire Fog. (*Holcus Lanatus* L.) A Great Trouble in Many Pastures. Very Common and Widely Distributed. A Hairy Grass Refused by Stock.

(To be continued.)

Tinning Large Articles of Copper, Brass, Cast and Wrought Iron (according to Bonsfield).—Pickle the articles in dilute sulphuric acid. Then place them for 8 hours with 64 parts of zinc in pieces in a composition heated by steam to 158 deg. F., and made by dissolving 15 parts of cream of tartar in 3,200 parts of water. Neutralize with 2 parts of precipitated chalk and add 7 parts of tin-salt dissolved in 320 parts of water.

[5] *Jour. Dept. Agric.*, Victoria, 1908.

[7] *Jour. d' Agric. Pratique*, 1897.

[8] As noted below, Mr. H. L. Bolley started spraying investigations in the United States in 1896, and says they were perhaps the first experiments of the kind conducted in any country.

[10] Fifth Annual Report on the Destruction of Charlock in Corn Crops in 1903.

[11] *Deut. Landw. Presse*, February 6th, 1909.

[12] *Farmer and Stock Breeder*, June 13th, 1910.

[13] Press Bulletin No. 9, 1903.

Correspondence.

Solar Power

To the Editor of the SCIENTIFIC AMERICAN:

I have read with much interest the articles appearing in the SCIENTIFIC AMERICAN of January 21st, 1911, and the SCIENTIFIC AMERICAN SUPPLEMENT for January 21st, 1911. Previous to the reading of these articles in the SCIENTIFIC AMERICAN I had read them in one of the London scientific papers.

You head the article in the SCIENTIFIC AMERICAN as follows: "Whereas Fessenden assumes that water can be raised by the sun's rays to its boiling point, the highest temperature which is mentioned in scientific literature within our knowledge is 65 deg. Cent. or 149 deg. Fahr."

We have in an actual business way anticipated practically everything Prof. Fessenden writes about. To prove this, we are sending you one of our catalogues published some three or four years ago. Since the publication of this catalogue, we have greatly improved the absorbing qualities of our heater, and have greatly simplified the construction.

We have spent $75,000 in the commercial exploitation of the sun's rays, and have built six different sun motors, and have proved them out in an absolutely scientific way. Prof. R. C. Carpenter of Cornell University has gone into the matter slightly, and admits that what we say is true as far as he can go. Mr. A. S. E. Ackermann, M.E., of London has tested the steam-producing qualities of our sun heater by actual careful tests spreading over three different experiments, and he has indorsed the fact that we can get the amount of steam out of the amount of area which we have assumed.

You are no doubt right that you have not seen higher temperatures than 149 deg. Fahr. in scientific literature. The fact, however, remains that we have obtained in this high latitude an apex temperature of 267 deg. Fahr. and the production of 212 deg. atmospheric steam is an easy matter for us on any clear sunshiny day in this high latitude. In the tropics, where we intend to use the sun engine, we will no doubt get greatly higher temperatures than this. In this latitude in summer time, between 10 o'clock in the morning and 3 o'clock in the afternoon, atmospheric steam (212 deg. Fahr.) can be produced in paying quantities.

The problem of constructing a sufficiently cheap sun-heat absorber is not a serious one. We accomplished this over three years ago. The problem was to find a steam engine which will use the steam (or boiling water) produced by the sun-heat absorber in a proper way. The assumption that a low-pressure turbine will do this is entirely wrong. It is true a low-pressure turbine will run with the steam generated directly, or with the steam caused by the evaporation under a partial vacuum of a 212-deg. temperature water.

Owing, however, to the impossibility of getting a turbine to work with proper efficiencies with such widely varying quantities of steam, we have given this idea up after trying three different turbines.

We were therefore compelled to invent a low-pressure reciprocating engine, which uses with equal efficiencies (based on the thermal efficiency) the steam produced by the sun's rays at all times of the day from 7 o'clock in the morning until 5 o'clock in the afternoon in the tropics.

We have reason to believe that we are the only ones who have ever actually built practical sun-power plants. Everything we have thus far heard from has either been fictitious, or has been based on a very short and erratic series of operations and many breakdowns.

We have unquestionably solved the problem of producing sun power. However, we have found that in order to produce sun-power plants of 25 horse-power and over, up to 100,000 horse-power—the larger the better—the total cost of construction per brake horse-power, including everything, is $300. This will produce a power plant which gives fuel for absolutely nothing, cuts down the labor to less than a quarter, and cuts down the wear and tear to less than one-tenth of the best modern steam plant.

Counting the interest on the investment, we find that we can compete with $3 coal in the tropics at this stage of our knowledge. We cannot expect to bring sun power at once to an apex. We see many ways ahead of cheapening construction and increasing efficiency; and have no doubt that another ten years of experience will enable us to compete with $1 coal in the tropics.

It must be remembered that a sun-power plant, which in the tropics can compete with $3 coal (counting in the greater interest due to the greater investment), is at the present moment a very good commercial investment. There is room for a million horse-power in the true tropics, where coal is above $5 per ton, and room for easily an equal amount where coal is from $5 to $20 per ton. Those are, of course, the places where the first sun-power plants will be exploited.

Prof. Fessenden's idea of storing power by pumping water to a great height in tanks, is correct as far as it goes. But we can store a much greater power at greatly less expense by storing up the boiling water in the manner shown in our catalogue.

The sun engines which will be built during the coming five to ten years will be mainly irrigation engines, where the quantity of water pumped need not be of necessity steady during the twenty-four hours. If the sun-power plants are used for irrigation, the problem becomes much simpler because, in the first place, the water used for irrigation can be pumped through the condenser and then into the reservoir or on to the land, and then the atmospheric steam evolved can be used direct in the peculiar reciprocating engine which we have invented.

We have invented a reciprocating engine which has on low pressures far greater economy than any turbine or reciprocating engine. Prof. Carpenter tested this engine very thoroughly, and from his report dated February 24th, 1910, I will quote the following:

"I do not know of any other type of prime mover, steam engine, or turbine, having the same capacity, which could have done as well. I should certainly have expected 20 to 30 per cent higher steam consumption from any other piston engine, and 50 to 60 per cent from any steam turbine of the same capacity."

On sending Prof. Carpenter's complete report to London for the purpose of securing money, the London company sent over here Mr. A. S. E. Ackermann, B.Sc. (Eng.), A.C.G.I., A.M.I.C.E., M.R.S.I., who went over Prof. Carpenter's tests, and showed an even better steam economy, owing to the fact that he ran his engine to higher power by increasing the number of revolutions. Mr. Ackermann's best result was 26.5 pounds of steam at atmospheric pressure per brake horse-power.

Remembering that the engine tested was only a 30-horse-power reciprocating engine, you will find this economy quite remarkable. There are few 800-kilowatt turbines than can equal it, and the most of the 800-kilowatt turbines this little 30-horse-power reciprocating engine has beaten. When the size of this engine is brought to the 800-kilowatt mark, the economies would, of course, be much greater.

To recapitulate, we have this much-desired sun-power idea above the experimental stage; and we are going into the construction of actual working engines. We are now constructing a 25-horse-power sun plant which will be ready for testing on July 1st of this year, here in Tacony. It will be run until everything is found correct, and then sent to Cairo, Egypt, and tried there.

The reason why we can count on certain results is, that this will be the final one of a long series, all of which gave good results, and every succeeding one of which was better than the previous one. The great handicap that the sun-power inventor has is that the ordinary business man will not invest money in a scheme of this kind until he has been most convincingly shown. The money used heretofore has come from myself and personal friends, who have made good dividends from other inventions made by me.

There is a great similarity between sun power and aviation. You will at once admit that any business man, approached several years ago with a view of purchasing stock in a flying-machine company, would have feared the sanity of the proposer. After it has been shown conclusively that it can be done, there is now no difficulty in securing all the money which is wanted, and very rapid progress in aviation is from now on insured. We will have to go through this same course.

You have published in your paper a great deal of my work, and a number of my inventions, for instance, the building of the City Hall tower of Philadelphia; the wire glass machines; the Simplex piling operations; the wool-degreasing machines; and you did publish my first ether sun engine.

Philadelphia, Pa. FRANK SHUMAN.

American and Argentine Dreadnoughts

To the Editor of the SCIENTIFIC AMERICAN:

The interesting article in the June issue of the Navy and the reply thereto in the SCIENTIFIC AMERICAN of August 27th concerning the relative merits of the Argentine battleships "Rivadavia" and "Moreno" and the American battleships "Wyoming" and "Arkansas," give rise to many interesting comments.

Whether the "Rivadavia" or the "Wyoming" will prove to be the better vessel cannot be positively decided until the two vessels have been launched and completed. Still, with the data at hand, one can see that the estimated speed of the "Rivadavia" (22½ knots) is two and a half knots greater than that of the "Wyoming." This in itself is a heavy handicap on the American vessel, and would put her in an inferior class when speed alone becomes the issue.

Turning to the displacement, we find that the Argentine vessel has the advantage by 2,957 tons over the "Wyoming's" displacement of 27,243 tons. The coal supply of the "Rivadavia" (4,000 tons) is three-quarters greater than that of the other vessels. This would enable them to keep the sea longer, besides allowing a wider radius of action.

In the event of a naval campaign by a squadron of "Rivadavias" against a squadron of "Wyomings," the greater radius of action and superior speed of the former might decide the fate of a campaign, and compel the slower vessels to adopt a more cautious plan of attack, so as to husband their inferior resources.

Maneuvers in naval warfare are often as decisive as a pitched battle, and far less expensive in the matter of blood and treasure. The presence of a "fleet in being" has often changed the entire nature of a campaign, as in the case of Lord Torrington. After the battle of Beachy Head in 1690, that officer's disposition of his fleet no doubt prevented De Tourville, the French admiral, from moving troops across the channel into England. Again, during the Russo-Japanese war, Admiral Essen's Vladivostock squadron raided the east coast of Korea, and sank several Japanese transports. Subsequently, these fast vessels moved over to the Pacific coast of Japan, and threatened Yokohama. Although these movements did not make Togo release his grip on Port Arthur, or compel Oyama to abandon the advance on Liao-Yang, Kamimura's Japanese squadron was compelled to remain in the Straits of Tsushima, so as to protect the troopships going to Manchuria. Kamimura's four armored cruisers would have been a welcome aid to Togo at the battle of August 10th, 1904. Had fortune continued to favor Essen and Bezobrazoff they might have accomplished a great deal more, and perhaps changed the character of the war.

Again, in our war with Spain, the formation of the Eastern Squadron under Commodore Watson for a descent on the Spanish coast helped to compel the slow Spanish fleet to abandon the voyage to Manila and return to Spain. Watson's fast squadron, although it never left West Indian waters, nevertheless had a powerful influence in bringing the war to a close. In this way it can be easily seen that the fast Argentine vessels would possess considerable advantage over their American contemporaries when operating against each other.

In the matter of the fire superiority, the vessels are equally armed in the main batteries, but the arrangement of the turrets gives the "Wyoming" a weaker head-on fire than the "Rivadavia." The former vessel can train only two turrets directly ahead on a line with the keel, while the latter can support her two forward turrets' fire by the two midship turrets, one on each side of the vessel. These have an arc of forward fire of ninety degrees. In the American vessels the two midship turrets have only an arc of fifty degrees forward fire, and they would thus become masked as the line of fire became dead ahead.

Turning to the broadsides, the two vessels are practically equal, while in their stern fire almost the same condition prevails. In the latter case, four turrets would have a direct fire. On the American vessels, the line of fire would be on a line with the keel, while on the Argentine vessels the stern fire would be as powerful as the forward fire, and owing to her *echeloned* turrets amidships, the fire superiority would be identical. Hence as long as the *echeloned* turrets remained intact, the "Rivadavia" could fight on her own terms, while to equal her the "Wyoming" would have to present her stern fire, or else maneuver into a broadside position and rake her opponent.

When we come to the matter of armor protection we can simply keep in mind Admiral Farragut's maxim, "The best protection against an enemy's fire is a well-directed fire of your own." Armor, while essential, is not absolutely a security against gun fire, when we consider that the heaviest shot are capable of penetrating very thick armor.

In the event of battle, good seamanship together with good tactical management and gunnery would decide the affair, although it clearly appears that the "Rivadavia" would have the advantage at the start.

Brooklyn, N. Y. GERALD ELLIS CRONIN.

A handy way to remove a wood screw that has stuck, and is so tight that there is danger of twisting off the head, is as follows: Heat a poker or a piece of round iron red hot, and hold it against the screw head for a little while. Wait a few minutes for the screw to cool off, when it will be found that the screw can be removed quite easily with the same screw driver that just previously would not perform the work. The explanation is simple. The red-hot poker heats the screw; the screw expands, and makes the hole it is in just a bit bigger. The screw then cools down and resumes its original size, leaving the hole in the wood a size larger. The writer has given this little kink a fair test in taking screws out of some oak boards that were built in a refrigerator where the wood had become set around the screws.

INDEX OF INVENTIONS

For which Letters Patent of the United States were issued for the Week Ending January 24, 1911,

AND EACH BEARING THAT DAT

[See note at end of list about copies of these patents.]

Accelerator, H. E. Wimperis 982,336
Acetylene generator, F. B. Ray 982,690
Acid and metal peroxide, making nitric or other oxynitrogen, H. S. Blackmore 982,466
Acid di-iodid, taric, Arnaud & Posternak 982,656
Adjustable bracket, J. Knape 982,279
Advertising device, F. E. Evans 982,355
Advertising device, live motion, Medvecky & Kauser 982,685
Air brake systems, testing device for, F. A. Gilfus 982,714
Air compressed, F. M. Prather 982,632
Air forcing apparatus, I. H. Spencer 982,393
Airship, C. L. Anway 982,561
Airship propelling mechanism, M. Vaniman 982,647
Alarm. See Incubator alarm.
Amusement device, A. C. Grunwald 982,289
Amusement device, rocking boat, W. S. Tothill 982,314
Antiskidding device, W. P. Scholl 982,304
Archer's bow, G. C. Setchell 982,748
Automatic cup, B. Gabler 982,585
Automatic switch, C. R. Bailey 982,410
Automobile body construction, L. M. Fuller 982,422
Automobile engine starting apparatus, R. E. Gutig 982,596
Automobile fender, G. W. De Clements 982,577
Automobile starter, J. McKissick 982,382
Automobiles, power transmission attachment for, Zybach & Braun 982,756
Autosleigh, P. F. D. Bellveau 982,344
Axle, J. M. Whitton 982,403
Balancing machine for rotatable bodies, C. H. Norton 982,629
Baling press, F. Newton 982,627
Baling press, G. F. Walters 982,650
Balloon, dirigible, L. V. Feuillet 982,356
Barrel trussing and hoop driving machine, C. W. Sharrock 982,749
Bath attachment, C. F. Netschert 982,626
Battery, H. W. Darby 982,576
Bearing, A. E. Clark 982,250
Bearing with loose guard ring, roller, C. S. Lockwood 982,512
Bed bottom fabric, C. B. Fraley 982,713
Bed, spring, E. Roberti 982,391
Bedstead, F. G. Gale 982,265
Belt fastener, F. M. Linderman 982,374
Binder, loose leaf, J. G. Griesinger 982,593
Binder, loose leaf, G. E. Stansell 982,750
Biscuit, dog, C. Ellis 982,711
Blind fast, W. H. Swift 982,396
Block. See Chuck block.
Blower, boiler, E. B. Barnhill 982,459
Boiler nozzles, making steam, C. F. Bennett 982,463
Boiler tube cleaner, J. Wiechmann 982,652
Book stand and music rack, adjustable, Z. H. Blouch 982,567
Bookbinding machine, J. Murray 982,438
Bottle capping machine, H. Barry 982,231
Bottle capping machine, E. C. Miller 982,521
Bottle, non-refillable, P. H. Grinke 982,268
Bottle, non-refillable, T. L. Weigert et al. 982,325
Bottle non-refillable, W. J. & H. L. Lasher 982,506
Bottle stopper, J. C. Schleicher 982,692
Bottles, combined breast and nipple for sealing, W. M. Decker 982,776
Box Power fastener, L. D. Fox 982,712
Box making machine, G. D. Parker 982,439
Boxes, cases, etc., lid for, S. Maggiorani 982,436
Braking system for hoists, safety dynamic, McKee & Schnabel 982,284
Broiler gridiron, C. W. Shields 982,771
Brush making machine, Young & Lebherz 982,340
Buckle, self-locking, Knight & Jardine 982,453
Buggy seat, F. Passebury 982,484
Bulkhead, M. M. Upson 982,697
Button setting machine, G. E. Parker 982,296
Buttons on shoes and other articles, machine for fastening, W. Perkins 982,440
Cable clamp, wire, J. J. Piper 982,742
Cableway, T. S. Miller 982,737
Calculating machines, key for keyboard, D. E. Felt 982,416
Calendar, J. F. Bennet 982,253
Calipers, Rogers & Creech 982,635
Cameras, multiple exposure attachment for, C. Drake 982,707
Cameras, screen and plate holder for engravers', U. M. Norton 982,294
Candy package, A. P. Becker 982,461
Cane knife, E. M. Hibbler 982,674
Canopy switch, H. B. Benjamin 982,345
Car couplings, automatic uncoupling device for, J. F. Robertson 982,532
Car dumping apparatus, mine, C. A. Griffin 982,426
Car journal boxes, core for molding, J. W. Gibney 982,588
Car stake, M. J. Skube 982,308
Car sweeping machine, J. Steiner 982,694
Carboy cleaning device, A. J. Berg 982,566
Carburetor, B. N. Pierce 982,297
Carburetor, Huggins & Parker 982,428
Carburetor, D. J. Hayward 982,490
Card case, E. N. Anderson 982,758
Carline, metallic, E. C. Covert 982,412
Carrier. See Child carrier.
Cartridge register, automatic, Maple & Turner 982,678
Cartridge shells, machine for breaking up, H. D. Hodge 982,496
Casing shoe, A. G. Heggem 982,491
Casting ball, A. N. Bailey 982,409
Casting, R. B. Browne 982,572
Castings, producing sound metal, L. Weiss 982,326
Cellulose films goffered article made from, J. Brandenberger 982,467
Cellulose from fibrous materials, producing, G. H. Marshall 982,379
Child carrier, M. E. Macfarlane 982,376
Chuck block, D. Sisson 982,533
Chuck jaws, O. R. Altwein 982,559
Chute, feed, T. W. Jenkins 982,725
Cigar holder, lighted, C. W. Humphreys 982,429
Clamping device, A. B. Wood 982,773
Clasp or holder, A. J. Pollock 982,298
Classifier, I. H. Spencer 982,640
Closet seat, child's N. P. Wallace 982,553
Clutch, N. E. Heston 982,605
Coating object and making the same, L. H. Backeland 982,230
Coke, etc., apparatus for determining water in, J. A. P. Crisfield 982,765
Coke oven spraying mechanism, Mitchell & McCreary 982,625
Coke quenching, screening, and loading apparatus, A. Goodall 982,590
Collar, L. B. Tim 982,646
Column and beam, J. H. Campbell 982,472
Communion service, Cree & Davis 982,351
Concrete bodies, making metallic cores for, H. Eberlein 982,485
Concrete column mold, H. J. Eberle 982,769
Concrete roadway, E. M. Chadbourne 982,247
Condenser, E. Wiki 982,404
Condiment holder, T. F. Lacy 982,371
Conduit, flexible, C. Chernack 982,248
Coop, brooder, P. H. Brainard 982,703
Copying machine, multiple, W. Sableford 982,543
Cord from quill substance or strips, mechanism for the manufacture of, W. Webster 982,322
Core barrel, double tube, M. Ahearn 982,456
Core vents, means for making, C. Hansen 982,670
Corrugated bar, A. L. Johnson 982,682
Cot, adjustable invalid, R. R. Miller 982,289
Cotton gin, double-breasted huller, J. L. Hart 982,672
Cotton pickers, stripper for, O. C. Hough ton 982,676
Cotton stalk cutter, R. A. & C. F. Leatherwood 982,613
Coupling. See Shaft coupling.
Crate, folding, A. J. Cone 982,350
Crucible cover, T. McGrath 982,437
Current protector, high tension, Lincoln & Well 982,281
Current rectifier, electrolytic alternating, A. S. Hickley 982,494
Curtain hanger, window, C. A. Knight 982,610
Cut out, electrically operated automatic, A. Brown 982,346
Cylinder liner, J. W. Moore 982,739
Damper controlling apparatus, thermostatic, B. C. Wickes 982,331
Desk, tray, L. Senge 982,538
Disappearing chair, C. E. Edmund 982,710
Dish washing machine, C. H. J. Dig 982,578
Disk crank, Sutherland & Brown 982,545
Door bracket, burglar proof side, J. J. Acker 982,341
Door fastening device, emergency exit, H. Pincus 982,388
Door, grain, W. H. Fisher 982,261
Door hanger, I. W. Davis 982,257
Door lock, H. L. Dougherty 982,706
Doors, windows, etc., fastening device for, B. Randon 982,633
Drill press, J. C. Mullinnix 982,740
Drilling machine, W. Wetherbee 982,755
Dyestuff, disazo, A. L. Laska, 982,507 to 982,509
Electric conductor molding, S. M. Burk 982,764
Electric furnace, C. F. J. Forssell 982,420
Electric machine for maintaining a constant electromotive force under variations of speed, dynamo, M. W. W. Mackie 982,377
Electrical conductor terminal or lug, C. E. Baird 982,503
Electrical current arrester, excessive, M. E. Vaughn 982,551
Electrical effluvia, apparatus for producing and utilizing, L. Gerard 982,587
Electrical resistance, J. F. McElroy 982,735
Electrode for flaming arc lamps, Allen & Conn 982,407
Electrode, porous cup, F. J. Kamperdyk 982,729
Electrolytic cell, A. S. Hickley 982,493
Elevator controlling means, A. Amory 982,457
Elevator safety appliance, H. W. Sayles 982,536
Elevator safety device, automatic, H. P. May 982,519
Elevator safety floor, A. Z. Wilson 982,333
Elevators, liquid container and valve mechanism therefor particularly applicable for use in water and like, A. E. Hodder 982,364
End gate, H. J. Anderson 982,560
Engine. See Gas engine.
Engine sparker, explosive, E. Canedy 982,473
Engines and analogous purposes, igniter for internal combustion, H. W. Aylward 982,343
Envelop, W. H. Griffin 982,594
Explosion motor, G. Bruton 982,468
Fan, rotary, P. P. Ryan 982,691
Faucet, J. F. Hill 982,675
Faucet, filtering, F. Koss 982,434
Featherbone blade machine for manufacturing, W. Webster 982,323, 982,324
Feeding apparatus, hog, C. G. Howard 982,678
Ferry slip, R. T. Stone 982,643, 982,644
File, matrix, G. H. Gillin 982,554
Filing cabinet, W. L. Dunham 982,767
Filing drawer, C. E. Flanders 982,262
Filing system, E. A. Dunn 982,602, 982,708
Fire box, Jacobs & Shupert 982,723, 982,724
Fire door and shutter, F. L. Salmo et al. 982,303
Firearms, light attachment for, C. A. Lewis 982,380
Fireproof window frame, H. E. Vance 982,317
Fishing reel, W. Shakespeare, Jr. 982,305
Flagpole attachment, H. G. Suhr 982,645
Flexible pipe, W. T. Donnelly 982,482
Float, J. E. Lynch 982,615
Floor or wall connector, electrical, S. E. Steele 982,544
Floor strip, removable, W. S. Mitchell 982,522
Floor surfacing machine, A. A. Bagalio 982,759
Flying machine, H. A. Moore 982,290
Flying machine, E. D. Appley 982,700
Foot glove brace, H. Fischer 982,664
Fulcrum, forged steel, E. S. Smith 982,445
Funnel, Q. C. Adams, Jr. 982,557
Furnaces, steam nozzle for steam fan, G. de Grahl 982,591
Fuse, inclosed, C. R. Moellendorf 982,738
Gage and straight edge, combined, J. H. Miner 982,624
Game apparatus, G. F. W. Schultze 982,747
Gang edger, L. Harlow 982,602
Gas burning light, A. L. Geyer 982,271
Gas compressing apparatus, multiple effect, G. T. Voorhees 982,753
Gas controller or regulator, E. W. Blake 982,702
Gas engine, R. Bryden 982,394
Gas generator, acetylene, J. S. Rhea 982,389
Gas machines, mechanical motor for, R. J. Walther 982,321
Gas, manufacture of, G. H. Waring 982,754
Gas to burners, automatic apparatus for controlling the supply of, R. B. North 982,384
Gate. See End gate.
Gear, change speed, J. M. I. Girin 982,666
Gear generating machine, E. R. Fellows 982,581
Gearing, D. M. Wenger 982,327
Gearing, W. L. Haynes 982,603
Gearing, reversible transmission, C. M. Rhoden 982,530
Glass article, prism, F. L. O. Wadsworth 982,772
Globe support, A. G. McArdle 982,622
Glue spreading machine, R. N. B. Campbell 982,348
Gold leaf, composition for making, L. Kurz 982,370
Grader, road, D. P. Brininger 982,427
Grain shocker, M. Steuslet 982,642
Grinding commutators of dynamos and motors, machine for, W. H. Jordan 982,367
Grinding machines, wheel feed for, C. H. Norton 982,628
Grinding mill, W. F. Gunn 982,595
Gum from its vegetable source, separating rubber-like, W. A. Lawrence 982,373
Hammer drill, A. W. Taylor 982,397
Harrow, H. E. Kinney 982,607
Harvester, corn, I. Fetters 982,582
Hat cleaning pad holder, H. J. P. Rottger 982,534
Hat fastener, J. Wood 982,264
Hat pin, safety, H. Jones 982,727
Heating apparatus, J. M. W. Kitchen 982,432
Heating, cooling, and ventilating buildings, apparatus for, R. Hodgen 982,721
Heating systems, thermostatic controller for fluid, C. E. Adair 982,229
Heel nailing machine, C. R. Towle 982,550
Hides, skins, and the like, machine for treating, G. B. Norgrave 982,523
Hook, G. Herring 982,604
Hose or nozzle holder, G. Habig 982,597
Hub attaching device, L. Ray 982,300
Hub attaching device, J. B. Rice 982,745
Ice pick, D. W. Baker 982,564
Impedance device, W. R. Garton 982,266
Incubator alarm, W. M. Kelly 982,503
Incubator and nursery, electric, A. Beckstrom 982,462
Internal combustion engine, R. W. Coffee 982,251
Jewelry, manufacturing, M. J. Bonniol 982,237
Jewelry safety catch, L. E. Ladd 982,372
Keyboard machines, key for, D. E. Felt 982,417
Knitting machine attachment, J. H. Brinsley 982,238
Lace retainer, sheet, F. M. Willis 982,332
Lacing hook, J. J. Jordan 982,728
Laminated board, E. C. Hiscock 982,720
Lamp, electric, J. O. Camp, Jr. 982,470
Lamp globe or shade, gas, T. J. Lile, Jr. 982,511
Lamp glower, electrical incandescent, O. M. Thowless 982,751
Lamp, incandescent gas, C. A. Campbell 982,471
Lamp, miner's, G. Laws 982,612
Lamp, portable electric hand, H. P. Wellman 982,651
Lamp socket, incandescent, F. E. Seeley 982,693
Lantern bracket, R. H. Blair, Sr. 982,762
Lead corroding pot and buckle, combined, A. J. Meier 982,285
Leather glazing machine, W. B. Turner 982,398
Level, spirit, F. Ekvall 982,260
Lifter. See Track lifter.
Liquid fuel burner, H. H. Akers 982,342
Liquid fuel burner tip, Goodwin & Low 982,424
Liquid separating device, H. H. Wheeler 982,328
Liquids or solids from gases, device for separating, J. W. Gamble 982,488
Load transporting device, H. O. Adam 982,654
Lock, P. Toth 982,699
Loom, narrow ware, F. Benz, Jr. 982,464
Loom take-up mechanism, A. E. Rhoades 982,390
Looms, bobbin stripper for filling replenishing, S. N. Paquette 982,741
Lubricant container, H. P. Carrington 982,349
Lubricator, W. A. Wood 982,335
Mail bag catcher, C. E. Boone 982,568
Mail marking machine, W. D. Doremus 982,415
Manure spreader, W. N. & W. N. Whitely, Jr. 982,330
Match box, S. C. Hirschberg 982,363
Match igniter and waste match receiver, L. Re 982,301
Matches, toothpicks, or the like, receptacle for holding, G. W. Coble 982,411
Measuring machine, rope, M. E. Barton 982,460
Meats, wrapping for cased, Hoefer & Strohbaecker 982,497
Medicinal applicator and swab, J. A. Bartholomew 982,232
Merry-go-round, D. Stewart 982,310
Milling apparatus, L. B. Willoughby 982,334
Miter box, W. A. Burger 982,706
Moistener and sealer for envelops, F. R. S. Ditmars 982,353
Mold, W. Burk 982,241
Molding flask, Mott & Whitehead 982,687
Motor control, inductive, A. Sundh 982,695
Motor controller, C. T. Henderson 982,362
Motor controlling device, A. J. Horton 982,364
Mouse trap, C. J. Edwards 982,486
Mower and tedder, combined, C. Milstead 982,686
Musical instrument, H. G. Lehnert 982,732
Musical instrument players, note sheet feed mechanism for, C. F. Jones 982,277
Nitrogen compounds, preparation of, Meyer & Stillesen 982,288
Nitrogen fixing organisms in agriculture or horticulture, use of, W. B. Bottomley 982,569
Nitrogen, preparation of lime, J. M. A. Stillesen 982,311
Note sheets, expression marking for, P. K. Van York 982,648
Numbering device, W. Flett 982,263
Nut lock, H. M. Smith 982,392
Nut lock, J. Schuler 982,537
Nut lock, T. L. King 982,683
Nut lock, R. M. Blakey 982,768
Nut, self-locking, M. Jacobs 982,502
Oil and gas burner, R. L. Frink 982,584
Oil, apparatus for feeding, W. Kelly 982,730
Oil burner, H. L. Albee 982,655
Oil gun, J. Dickens 982,481
Oil switch, S. B. Condit, Jr. 982,253
Oiler, axle box and wheel, J. J. Gilroy 982,715
Ore classifier, hydraulic, J. N. Flood 982,583
Ore desulfurizing apparatus, refractory, C. A. Case 982,243
Ores, reducing and desulfurizing refractory, C. A. Case 982,245
Organ, electrically operated, W. B. Fleming 982,419
Orthodontia apparatus, R. Wiles 982,406
Outlet box, C. Rudkiewicz 982,535
Oven, baker's, J. M. Gautvoort 982,665
Pail and heater, combined lunch, G. B. Hunter 982,273
Paint and varnish remover, J. S. Patty 982,524
Painter's jack, E. Shepherd 982,306
Pantograph, Jacobs & Klebs 982,608
Paper box making machine, Purchas & La May 982,744
Paper feeding machine, F. L. Cross 982,255
Pen filler, fountain, H. B. McKee 982,285
Pen, fountain, L. I. Perry 982,527
Pencil holder, R. E. Kendall 982,504
Photographic printing apparatus, Fretter & Marsh 982,357
Pianos, tuning pin lock for, F. W. Gotterke 982,425
Pillow holder and body prop, combined, M. M. Abbot 982,558
Pillow, sanitary, V. Reblun 982,442
Pin. See Hat pin.
Piping safety device, J. Koenig 982,505
Planer, crank, Latter & Gies 982,375
Planter, corn, J. Vinton 982,649
Plow, J. L. Jackson 982,681
Plow, motor, W. A. Dawson 982,480
Plow, rivet disk, C. E. Eacrett 982,709
Plow, steam gang, W. S. Springer 982,448
Plumb bob pocket, W. D. Cater 982,476
Pocket book holder, A. W. Campbell 982,242
Pole erector and setter, R. W. Scott 982,443
Pole strand, electric, L. Martin 982,380
Pool and billiard table, combination, I. Freed 982,421
Post, R. D. Redwine 982,529
Poultry house, P. Rush 982,435
Pressure testing device, high and low, McKenzie & Morrison 982,520
Printing apparatus, L. M. Todd 982,752
Printing machine, C. H. Mann 982,512
Projectile, A. Wratzke 982,338
Projectile, G. E. Wells 982,402
Propulsion, jet, P. Skouses 982,540
Prospecting device, W. & C. Centala 982,246
Pulverizer, centrifugal impact, D. O. Marks 982,516
Pump, Bickel & Pierce 982,761
Pump, air, J. Dickens 982,660
Pump, hand, C. S. Hardy 982,601, 982,671
Pump valve, J. E. Householder 982,677
Rack. See Work supporting rack.
Radiator, J. A. Wilson, Jr 982,334
Rail anticreeping device, J. G. Wolf 982,337
Rail chair, J. N. Bonnell 982,236
Rail straightener, J. Contos 982,254
Railway frog, Hoskyn & Biddlemen 982,272
Railway spike protector, W. L. Gregory 982,592
Railway tie, C. O. Pearce 982,525
Railway tie and fastener, W. F. Walker 982,452
Railway tracks, resilient support for, H. H. Tunis 982,315
Ratchet mechanism, G. O. Leopold 982,510
Razor blade stropping apparatus, F. H. Hoffmann 982,722
Refractory material, H. A. D. Collins 982,252
Refrigerator, J. Thalheim 982,313
Refrigerator car, A. G. Brown 982,571
Resistance, reinforced grid, H. J. Wiegand 982,557
Ribbon holder, baby, W. J. Hedenstrom 982,361
River bank protector, Maxey & Estep 982,621
Rope, jumping, T. L. Webster 982,555
Rope tightener, F. & S. Gerlach 982,717
Rotary engine, W. F. Wheeler 982,329
Rubber plate for shoes, J. P. Kline 982,278
Safe, money, J. Nutry 982,688
Safety lock, A. J. Perrin 982,529
Sandpapering roller, P. Baggalio 982,774
Sash balance and antirattler, combined, C. R. Scharlandt et al 982,637
Sash balancing construction, W. Elmer, Jr. 982,487
Sash fastening, J. M. Winwright 982,699
Sashes of greenhouses, etc., lifter for, D. Iliffe 982,501
Saw jointing tool, D. G. Andrews 982,458
Sawing machine, wood, E. C. Swafford 982,312
Sawmill carriages, track scraper for, E. P. Hueber 982,679
Scaffold swinging device, G. Fitus 982,663
Scraper and grader, W. H. Violett 982,319
Scraper and grader, road, G. K. Smith et al 982,309
Screen, J. Guentner 982,270
Screw for channelers, double feed, A. E. Champagne 982,478
Seal, package and letter, R. Archer 982,562
Sediment remover, A. Martinelli 982,734
Sewing machine attachment, F. Marak 982,619
Sewing machine, overseaming, A. Grieb 982,717
Sewing machine thread lock, W. R. Blair 982,234
Shade roller, S. Hartshorn 982,359
Shaft coupling, J. L. G. Rahder 982,299
Sharpening device, lawn mower, Gerde & Kelly 982,423
Sheet cutter, G. Potstada 982,743
Sheet feeding machine, F. L. Cross 982,256
Shield, F. R. Hertford 982,492
Shifting mechanism, A. B. Vik 982,399
Shocking machine, W. P. Spooner 982,447
Shoe fastener, E. C. Rosencranz 982,746
Shoe polisher, G. Metzger 982,287
Shoe stretcher, C. B. Kosters 982,369
Shoe, swimming, C. Vagtborg 982,316
Shoe, waterproof, S. H. Yerkes 982,339
Shoemaker's tool, W. Hanna 982,599
Shutter holder, H. M. Hart 982,718
Shutter holder, window, T. Devlin 982,414
Shuttle mechanism, Theisen & Keller 982,548
Sign, electric, A. V. Dichl 982,352
Skate, C. Brown 982,239
Slack adjuster, Madden & Koehler 982,616
Sliding pole opening guard, E. C. Delene 982,481
Smokers' pouch, cigarette, Naramore & Barnwell 982,292
Snap switch, rotary, G. B. Thomas 982,549
Snow and the like melting apparatus, O. A. Ringbom 982,531
Soap dispenser, liquid, T. J. Dunn 982,768
Sole clamp, shoe, D. C. Smith 982,541
Sole pressing machine, J. Gouldbourn 982,267
Spark deflector, C. F. Vermillion 982,318
Spark plug, E. Canedy 982,474
Speed indicating system, M. R. Hutchison 982,499
Spinning and doubling frame guard, J. Gregory 982,667
Spring motor, A. L. Smith 982,444
Square, separable, V. C. Rosenberger 982,636
Stamp canceling and postmarking machine, W. D. Doremus 982,579
Stamping and severing machine, blank, G. Charleton 982,475
Stand. See Book stand.
Starch, B. Herstein 982,673
Steam boiler, E. D. Caldwell 982,347
Steam boiler, R. Mackay 982,733
Steam engine with piston controlled exhaust ports, J. Stumpf 982,395
Sterilizer, combination, S. T. Pulliam 982,528
Stitching machines, guide off mechanism for, Theisen & Keller 982,547
Stove, folding camp, A. Roncaglia 982,302
Stoves, and iron attachment for gas, Markowski & Kreckowsky 982,378
Strainer and cover, combined, G. J. Bernau 982,760
Street sweeper, C. C. Brooks 982,570
Surfacing machine, G. Alloway 982,408
Sweep rake approach, N. C. Talmer et al. 982,393
Sweeper, L. Brucker 982,240
Switch. See Automatic switch.
Switch throwing mechanism, N. C. McConahy 982,623
Table base lock, extension, H. M. Hanson 982,600
Talking machines, automatic stop for, D. C. & J. W. Nelson 982,293
Tape, hanger, A. H. Caldwell 982,594
Telegraph, printing, C. K. Jones, 982,274 to 982,276
Telegraphic dot transmitter, H. H. Smith 982,638
Telegraphy, system of, R. L. Dean 982,659
Telephone mouthpiece, L. Steinberger 982,641
Telephone system, lockout party line, A. Swenson 982,546
Telephonic instrument, S. L. Van Aklu, Jr. 982,450
Tether, J. W. Brown 982,469
Time alarm for hotels, etc., electric, G. M. Hinman 982,495
Tire, E. F. Reed 982,634
Tire antiskidding armor, W. M. Paul 982,630
Tire armor, H. C. Willis 982,453
Tire sleeve, A. E. Berg 982,465
Tires to wheel rims, device for securing, A. L. Cade 982,573
Tobacco pipe, Meloun & McCune 982,383
Tongs, cuspidor, J. R. Easton 982,354
Toy, C. A. Knight 982,609
Toy flying machine, C. D. Wilson 982,653
Track lifter and liner, E. Wartheu 982,401
Train controlling mechanism, automatic, N. Lang 982,611
Transmission gearing, J. L. Tebb 982,501
Transplanter, J. B. Carpenter 982,575
Trap, W. Parker 982,387
Tube winding device, C. F. Jenkins 982,430
Tubing covering machine, flexible, A. E. Chernack 982,249
Turn table mechanism for railway pile drivers and the like, W. Ferris 982,418
Twyer, C. A. Cee 982,244
Tympan sheet, E. D. Johnson 982,726
Typewriter, adding, J. G. Kingsbury 982,606
Typewriter and computer, combined, H. Marshall 982,517, 982,518
Typewriting machine, W. E. Shrayer 982,307
Typewriting machine, C. B. Corcoran 982,657
Typewriting machine, J. K. Lux 982,684
Typewriting machine, W. E. Barnard 982,701
Umbrella, folding, A. D. Hammett 982,489
Underreamer, P. H. Mack 982,513, 982,514
Universal joint, S. S. Hall 982,598
Valve, I. E. Mercer 982,286
Valve, air, L. Iversen 982,680
Valve, automatic, T. H. Walker 982,400
Valve for controlling the water inlet of automatic sprinkler systems, R. B. Hewitt 982,719
Valve, nonscalding, F. Hoffmann 982,498
Valve, plug and gate, Smith & Williams 982,446
Valves, spring holding device for, W. H. Shimpf 982,539
Vapor engine, J. Timmins 982,649
Vehicle, A. Waddell 982,320
Vehicle, R. W. Wagner 982,451
Vehicle shock absorber, motor, A. Loomis 982,282
Vending machine, F. I. Judson 982,431
Ventilator, R. O. Bone 982,235
Vise, W. S. Ducharme 982,483
Voting machine, J. H. McElroy 982,736
Voting machine, J. H. Dean 982,775
Voting machine lock out for primary elections, W. J. Lausterer 982,731
Wall, retaining, M. M. Upson 982,698
Wall seat wall bed, A. L. Haley 982,669
Walls, post and lath construction for, H. R. Myers 982,291
Washboiler attachment, Belodeau & Trudeau 982,565
Washing clothes, renovating feathers, canning, etc., machine for, McNorton & Stanley 982,385
Watches, etc., compensation balance wheel for, J. Chaoul 982,479
Water, purifying, W. B. Bull 982,704
Water purifying apparatus, W. B. Bull 982,705
Waterproofing compound and making the same, palmitin, E. Mas 982,620
Weighing device, D. C. McCan 982,381
Wheel, M. J. & F. P. Adams 982,455
Wheel fastener, J. E. Evans 982,413
Wheel with a special rim for the brake, A. Kastner 982,368
Wheels, machine for making metal, E. Einfeldt 982,350
Whiffletree, O. H. Smith 982,639
Whip holder, safety, L. C. Davis 982,258
Wind shield, sectional, W. G. Cox 982,658
Window construction, W. Elmer, Jr. 982,580
Window screen, Heaney & Beymer 982,490
Wire clasp, A. A. Lind 982,614
Wire gate, D. P. Page 982,296
Wire stretcher, O. M. L. & E. K. Smith 982,542
Wood, apparatus for extracting products from, F. Pope 982,631
Work bench stop, O. S. Gooch 982,716
Work holder, G. Hahn 982,698
Work supporting rack, adjustable, J. F. Cavanagh 982,477
Wrapping machine feeding mechanism, J. M. Patterson 982,770
Wrench, J. M. Gilman 982,589
Wrench, Mansfield & Matthews 982,617
X-ray tube, H. F. Waite 982,552
Yoke attachment, neck, C. White 982,556
Zwieback cutter, H. H. Hungerford 982,366

A printed copy of the specification and drawing of any patent in the foregoing list, or any patent in print issued since October 4th, 1859, will be furnished from this office for 10 cents, provided the name and number of the patent desired and the date be given. Address Munn & Co., Inc., 361 Broadway, New York.

Canadian patents may now be obtained by the inventors for any of the inventions named in the foregoing list. For terms and further particulars address Munn & Co., Inc., 361 Broadway, New York.

Some Mountain Winds and Their Names

BY C. FITZHUGH TALMAN.

THE march of human knowledge is from the particular to the general, and the nomenclature of science moves in the same direction. The individual manifestations of a natural law are first observed, and separately named; the law itself comes to light later, through the process of induction, and science then finds itself burdened with a multitude of names for one and the same phenomenon.

This fact is well illustrated in the history of wind nomenclature. In the modern scientific classification of winds, a score of names suffice for them all; in an earlier generation, Aeolus ruled over a populous kingdom, and his subjects possessed, for our forefathers, an individuality that was expressed in a nomenclature of bewildering magnitude. The "wind called Euroclydon" was, to St. Paul and his contemporaries, an isolated and distinct entity that no one thought of linking up with the general atmospheric circulation of the Mediterranean; and Milton's "herald of the sea" thought it necessary to question "every gust of rugged wings" about the fate of Lycidas, when he might better have applied at once to headquarters; i. e., to the center of the cyclonic storm that was sweeping the British seas when the unfortunate young Cantabrigian came to grief.

We now know that all mountain winds can be classified as (1) local breezes, of diurnal period, and (2) local modifications of more general winds. To the former class belong (a) the normal mountain and valley breezes, due to the alternate heating and cooling of the valley-bottom and the mountain slopes, and blowing up-valley by day and down-valley by night; (b) breezes of reverse direction—down-valley by day and up-valley by night—which occur when the circulation of a valley is overpowered by the more active circulation of an adjacent valley—a phenomenon of which the "Malojawind" of the Upper Engadine is the classic example; and (c) down-cast diurnal winds which occur when the mountain-sides are covered with snow and ice, and hence are colder than the surrounding air. Winds of the last class are typified in the *nevado storms* of the Andes, described by Moritz Wagner, and I propose to call these *snow-winds*, in the absence of any other well-established generic name. Such winds are, as Hann has told us, regularly observed at the foot of glaciers on warm days.

Of the general winds that take on special characteristics when they traverse a mountainous country there are two important groups, each of which bears the name of its most prominent representative. These are the *foehn* winds, or *foehns*, and the *bora* winds, which might, with propriety, be called *boras*. Both the foehn and the bora are descending winds, or *fall-winds;* but while the former is intensely heated and dried in the process of its descent, the latter, which blows from a cold inland mountainous region to a relatively warm coast, although also warmed to some extent, retains the character of a cold wind. The explanation of these processes is given in every treatise on meteorology or physical geography, and need not be repeated here.

The alternating day and night breezes of mountain valleys may be so gentle as to escape notice, or so strong as to excite interest and wonder, according to the configuration of the valley and the sharpness of the contrast between the diurnal and nocturnal temperatures. Before the days of scientific generalizations on this subject, such of these breezes as were especially strong and regular were apt to be given individual names, a great number of which still survive.

The local winds of the western Alps were first thoroughly studied about seventy years ago, by J. Fournet, and to him we are chiefly indebted for our knowledge of their nomenclature. The most famous of these breezes is the *pontias*. This is a cold nocturnal wind blowing out of a narrow valley that opens upon the plains of the Rhone near the town of Nyons, which once bore the sobriquet *Pontias*, due to the presence in its neighborhood of an old Roman bridge (*pons*). This *ventus pontiacus*—also called *le vent de St. Césarée d'Arles*—has been known from time immemorial, and was the subject of many speculative disquisitions before modern science was brought to bear upon it. Tradition ascribes the origin of this wind to the beneficence of St. Cæsarius, Archbishop of Arles, who is said to have brought it from the sea in a glove for the purpose of improving the fertility of the valley. In reference to this legend an alternative etymology of the name *pontias* derives it from the Greek and Latin *pontus*, the sea. The peasants claim that the olive trees upon which this wind blows produce fruit of a superior quality, and that its cessation is an omen of pestilence.

In the same valley with the *pontias* the up-valley day breeze is called *vésine*, a name which Fournet tells us means "bad wind." Good authority, however, derives this word from the name of a former division of Provence, viz., Venaissin, from the direction of which the wind blows.

Another local breeze of the French Alps is the *solore* or *solaure*, which blows at Saillans, along the narrow valley of the Drôme. Its diurnal periodicity is expressed in the name, which is equivalent to *solis aura*, "sun breeze." To the western Alps also belong the *vent du mont Blanc* ("Mont Blanc wind"); the *aloup de vent* ("wind wolf"), blowing by night down the valley of the Brevenne; and the *joran*, blowing down from the Jura mountains (whence the name) to the shore of Lake Geneva. The *joran*, Forel tells us, does not blow out onto the lake; but another wind does, viz., the *morget*, which is not a mountain breeze, but a regular nocturnal land breeze, alternating with a diurnal lake breeze called the *rebat*. The *morget* and the *rebat* are the homologues of the alternating land and sea breezes of ocean coasts. The *morget* is named from the town Morges; *rebat* is evidently from the French *rebattre*, in some one of its senses.

The Italian lakes are especially rich in local wind names, only a few of which can be mentioned here. On Lake Como the day breeze, blowing toward the head of the lake, is called *la breva;* the opposite night breeze *tivano*. On Lake Garda, and in the neighboring Etsch valley, the regular day breeze, blowing up-valley, is the *ora*—probably an archaic form of the Italian word *aura*, "breeze." The northerly night breeze is called *sover* or *sopero*, i. e., "upper wind"; just as on the lakes of the Austrian Salzkammergut the night wind, blowing from the upper end of the lake, is called *Oberwind*, its opposite, by day, being the *Unterwind* or *Niederwind*. Lake Garda has a score of other wind names, a list of which is given by F. Denza in his Italian version of Scott's "Elementary Meteorology," on page 498.

Of the many other local breezes that have special names I shall mention only the *Wisperwind*, the cold night breeze that blows out of the valley of the Wisper, a small affluent of the Rhine, and the *Erlerwind*, which blows in the Inn valley, north of Kufstein, in the Tyrol.

Turning now to winds belonging to the more extensive circulatory systems of the atmosphere, we come first to the *foehn*, which is undoubtedly the most interesting of mountain winds. The word *foehn* became naturalized in English before the German umlaut lost its "e," and the old spelling is generally retained in English texts, though the modern German form *föhn* is also met with. An argument in favor of the older form is the fact that the transition from *föhn* to *fohn* would be temptingly easy; at least to cis-Atlantic writers—and especially to cis-Atlantic printers—and antiquated German is preferable to a barbarous anglicization. *Fön* is an alternative spelling in German.

The history of the word *foehn* has been traced by R. Billwiller, and is a striking illustration of the vicissitudes that many wind-names have undergone. In the classical Latin wind-rose the west wind was called *favonius*, i. e., the "beneficent wind" (from the verb *faveo*); so called because it brought mild weather, melted the snow in spring, and promoted the growth of plants. While to the mariner, in all ages, the direction from which a wind blows is its most important characteristic, the agriculturist is more interested in its physical qualities and their effects; it is therefore not surprising that the Italian peasants who migrated to the northern slopes of the Alps transferred the name *favonius* to the wind that had the physical characteristics of the west wind in Italy, and this was the warm wind from the south. In the Rhaeto-Romanic dialects *favonius* became *favougn, favoign, fuogn, fuin*, etc., later Germanized into *foehn*. The evolution of the word, however, did not stop here. When the scientific study of the foehn was begun, its high temperature was accounted for by the hypothesis that it was a sirocco wind from the African deserts, which, after traveling northward at a great altitude, was in some manner brought down to the earth after passing the Alps. Dove thought it was an anti-trade wind from the Caribbean Sea. So far the name belonged exclusively to the Alpine region. The true theory of the foehn was given by Espy, and more fully by Hann; it was discovered that the foehn was simply a descending air current, heated by compression, and dry in consequence of having lost its moisture through condensation and precipitation during a previous ascent. Given this conception of the foehn, it was inevitable that the same phenomenon must occur in other parts of the world; and it was, in fact, found that the foehn is fairly common in mountainous regions everywhere, and has in many cases been given local names—*chinook* in western America, *zonda* in Argentina, *autan* in the south of France, etc. Thus *foehn* became a generic name for a very numerous class of winds. In its widest extension the word is not even limited to mountain winds, but is applied to *any* current of air that is heated and dried by compression during descent, and meteorologists to-day write of the "anticyclonic foehn" that gives warm weather and clear skies to the belt of descending air bordering a barometric depression.

The Alpine foehn has a large nomenclature, both scientific and popular. A "*wilder Föhn*" is especially violent, a "*Dimmerföhn*" relatively weak. The *foehn wall* (*Föhnmauer*) is the fringe of cloud that forms along the crest of the mountains over which a foehn is blowing. "Foehn sickness" is alleged to be experienced by some people during the prevalence of this wind. The foehn is nicknamed "*Schneefresser*" ("snow eater"), because it causes the snow to disappear with marvelous rapidity; the Alpine peasants have a saying that a day of foehn is as good as a fortnight of sunshine. The name "snow eater" is likewise applied in western America to the chinook. In northern Tyrol and Vorarlberg the foehn is called "*Türkenreifer*" ("maize ripener"); in Graubünden its sobriquet is "*Traubenkocher*" ("grape cooker"); in some parts of the Tyrol it is "*Mailänder*," because it blows from the direction of Milan.

With regard to the American *chinook* it need only be noted here that while the scientific chinook is always a foehn, the chinook of popular parlance may be almost any warm wind. Similarly, in Argentina the name *zonda* is applied not only to the westerly foehn wind, but also to a northerly sirocco wind. As to the etymology of these words, *chinook* is from the name of a family of Indian tribes settled along the Columbia River, but exactly why their name was applied to the wind is unknown; *zonda* is from the village of Zonda, in South America.

The *autan*, of southern France, is a recent addition to the foehn family; i. e., the fact that it is a foehn has only lately been discovered, through the investigations of E. de Martonne, professor of geography at the Sorbonne. It is a violent dry wind from the south or southeast, prevailing on the Atlantic slope of Haut Languedoc and in eastern Aquitaine, and has been found to be really an extension of a moist wind, the *marin*, blowing from the Mediterranean on the opposite side of the mountains.

In a recent letter to the author, M. de Martonne sends an interesting piece of information, not heretofore published, concerning the *autan*. One of his philological colleagues has investigated the etymology of this word, and finds that it comes from the Latin *altanus*, which usually meant a wind from the sea (*ex alto*). This seems to argue that the identity of the *autan* with the *marin* was recognized from early times. However, this conclusion must not be too hastily accepted, since the word *altanus* was undoubtedly variously applied by classical writers; and we have seen, in the case of *favonius*, how easily the ancient names of the winds were diverted from their original meanings.

As to the *bora*, which, as a generic term, includes the *mistral* of southern France, I shall say only a word regarding the terminology of the Adriatic bora, which is the type specimen of its class. A moderate bora is called *borina;* a very heavy one, *boraccia*—and whoever has experienced the ferocity of a boraccia will bear witness that the Italian pejorative suffix is fittingly applied. The wind blows in violent gusts, called *refoli* or *raffiche*, and fills the air over the sea with a mist of driving spray, the *fumarea* or *spalmeggio*.

TABLE OF CONTENTS.

PAGE

I. AERONAUTICS.—Rules Governing the Competition for the $15,000 Flying Machine Prize Offered by Mr. Edwin Gould. .. 68

II. AGRICULTURE.—The Destruction of Weeds by Chemical Means.—By Harold C. Long.—9 illustrations..... 76

III. ASTRONOMY.—Drifting of the Sun's Family.—By Arthur K. Bartlett..... 74

IV. CHEMISTRY.—The Corrosion of Iron..... 69
Polonium..... 71

V. ELECTRICITY.—Some Notes on Telephony.—By H. Harrison. —7 illustrations..... 68
What Electrochemistry Is Accomplishing.—II.—By Joseph W. Richards..... 70

VI. ENGINEERING.—The New Paris Electric Subway.—By Our Paris Correspondent..... 66
Paris as a Seaport.—By Our Paris Correspondent.—1 illustration..... 77

VII. MISCELLANEOUS.—Armament of Battleships..... 65
The Independence Bell of Mexico..... 75

VIII. NAVAL ARCHITECTURE.—The World's Greatest Ship—The "Olympic"—A 60,000-ton Ship..... 72

Industrial Alcohol

Its Manufacture and Uses

By JOHN K. BRACHVOGEL, M.E.

Size 6¼ x 8½ inches. 528 pages,
107 illustrations, Price $4.00, postpaid.

THIS is a practical treatise based on Dr. Max Maercker's "Introduction to Distillation," as revised by Drs. Delbruck and Lange. It comprises raw materials, malting, mashing and yeast preparation, fermentation, distillation, rectification and purification of alcohol, alcoholometry, the value and significance of a tax-free alcohol, methods of denaturing, its utilization for light, heat and power production, a statistical review, and the United States law. This is the latest and most authorative book published on the subject and is based upon the researches and writings of the most eminent of Germany's specialists in the science of fermentation and distillation. It covers the entire manufacture of alcohol from the raw materials to the final rectified and purified product. An illustrated circular and table of contents of this book will be sent free on application.

MUNN & CO., Inc., Publishers
361 BROADWAY, - NEW YORK